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Local Irrigation.

Climatologists are generally agreed that century by century conditions are fairly stable in spite of all the changes worked by man upon the face of the earth. Averages, however, are deceptive and the ordinary human being is more concerned with the variations from year to year than with the stability that may be manifest in history. Deforestation which has gone on so rapidly in the last half century is surely doing its work, if not directly in the rainfall, then unmistakably in promoting very great variations of run-off that have already injured the water powers of the country and are slowly and surely affecting the value of the land for agriculture.

Of course in the arid regions provision has been made and is steadily being made for systematic irrigation. The land that is apparently desert turns to a garden if there is an adequate water supply. The point to which special attention should be called is the necessity of opening a battle against the disastrous effects of deforestation in regions which have in the past been well watered. Of course something may be done by intelligent forestry which should in every way be encouraged. But so long as forests remain in private hands uncontrolled they will be ruthlessly skinned regardless of the damage inflicted on the community at large. There seems to be small hope of saving them in sufficient quantity to help the situation as regards water supply, so that having driven Nature from the field it is high time to see what engineering can do.

In point of fact it is at least a debatable question whether skillfully planned and executed irrigation works cannot beat Nature at her own game. Any one who is familiar with the wonderfully productive qualities of some of the reclaimed land of the arid belt realizes that by judicious use of water the regular yearly production can be greatly increased and the field can be made far more certain than in even the best regions of natural irrigation. In the existing state of things it is hardly more than making a virtue of necessity to look into local irrigation. By this is meant systematic planning for water supply as a measure of economy rather than of necessity. Wherever a good water supply can be obtained, either from streams or from wells, it is possible without great cost to introduce enough irrigation to offset the chances of the weather. The important question is the local availability of water and the conservation of the rainfall. Given the water, wind power furnishes a cheap and effective means of distribution, since small power steadily at work is all that is needed. The thing to be determined is the facility of natural storage and the chance of an underground supply. Here is a good task for the U. S. Geological Survey. A reliable underground supply, the result of subterranean storage of the run-off is very valuable, yet very little has been done toward a systematic survey. Starting from a fairly accurate knowledge of the geology of a region, the location of the water belts, with the help of tentative borings, should not be an extremely difficult task. Then when the beautiful topographical maps of the U. S. Geological Survey are being made it would certainly not be difficult to locate and make public the valleys easily available for storage of water supply with the rough data for their utilization. There will be in the future a good many artificial water powers and storage of the lesser valleys is available for irrigation.

The time has come when the hydraulic resources of the country ought to be investigated as carefully as any other source of wealth, else every year there will be a steady loss of available agricultural regions that cannot indefinitely be compensated by the opening of new territory. It should not be difficult to encourage the formation of artificial ponds, thus holding up some of the water now wasted. The water thus saved is actually more valuable than if it were held back by natural means since it can be used when it is wanted and when it is needed. There is a very large amount of semi-arid land in the country which is fertile enough under favoring conditions but extremely unreliable, failing badly in any but wet years. A large part of this can be saved by the intelligent use of local reservoirs, and the gain would pay a very large interest on the capital invested. There has been so little study of irrigation from the standpoint of the private individual that the economies of the situation have been overlooked. The big irrigation projects have generally been profitable when well

administered, and profitable to customers as well as stockholders. What they have done in regions requiring very heavy expenditures for long ditches and elaborate head works can be easily matched in districts less short of water supply. In the Southwest pumping water for irrigation by steam or gasoline engines, by windmills and electric motors has proved profitable enough to be carried out on a considerable scale. Given either some knowledge of the subterranean supply or local storage basins, even upon a small scale, the same process could be applied over a much larger territory. Intensive operations do not come naturally to the American, he wants to look out over his broad acres and abuses the climate if they are unproductive. Things have now come to a pass that demands localized attention, for the productive districts of the country are becoming so remote from the great centers that transportation is the chief factor in costs; America needs to learn from countries where land is scarcer than here and correspondingly appreciated.

The High Tension Crossing Evil.

The dangers attending the unprotected crossings of high and low-tension wires on overhead systems have been brought to the attention of engineers a good many times within the past two or three years, and there would be no excuse for referring to the subject at this time were it not for the fact that there still remain innumerable instances of hazardous construction in different parts of the country. There seems to be a disposition to take chances which is certain, sooner or later, to bring serious trouble and expense within its wake. A conspicuous example of the high-tension crossing danger occurred not many months ago at Brockton, Mass., where a prominent employe of the Standard Oil Co. was killed by the crossing of a telephone circuit with a high potential electric light wire. The dangers are in no sense imaginary.

Aside from the danger to life which faulty overhead construction entails, there is always the possibility of fires being started over a wide area in case a high and low potential contact occurs—provided the protective devices fail to do their work. The financial loss in such cases is likely to exceed the cost of proper protection a good many times over. A recent trip in Northern New England showed so many examples of inferior line construction—in some cases carrying 12,000 or 13,000 volts—that the hazard of the situation was most forcibly apparent. It naturally costs money to maintain overhead lines in first-class condition, but it is a matter of comparatively small expense per crossing to take a reasonable regard for the safety of adjacent high and low-tension circuits. An example of the simplicity with which such protection can be made is found at the Boston & Maine shops in Concord, N. H. Here a three-phase, 13,000-volt circuit is carried across the railroad tracks in a long span, directly over a pole line carrying two or three score of telephone wires. The power circuit is bare, and is supported on the usual porcelain insulators, but at short intervals each wire of the line is additionally protected from falling by vertical tie wires suspended from three overhead wires attached to an upper crossarm, each power wire having what amounts to a short-span catenary suspension throughout the entire crossing. The total cost of the protection could scarcely have exceeded \$10.00.

Elaborate methods of protecting crossings carrying voltages as high as 60,000 or over have been devised by the American Telephone & Telegraph Co., and in some cases exchanges have employed engineers to report on the condition of crossings in their territory and recommend pro-

tective measures. The subject is one of greater importance than it is considered in many quarters, and it deserves very careful attention by high and low potential operating companies. The cost of protection depends upon local circumstances, but in general it seems to be fair that the latest comer in the field should bear the burden, slight as it is per crossing. The total work to be done in this field deserves wise organization and planning.

Dredging of Ambrose Channel at the Entrance to the Harbor of New York.

The work of providing a ship channel of a minimum depth of 40 ft. at the entrance to the Harbor of New York is being carried on under circumstances of more than usual interest, not only on account of the magnitude of the work involved, but also chiefly in consequence of the fact that the contractors' and United States Government dredging plants are working concurrently. It will be remembered that the contract for opening Ambrose Channel was taken at nine cents per cubic yard, and that the work was to be done by hydraulic dredging throughout the improved channel, about seven miles long, between the 40-ft. contours. The material to be removed, on the inner slope of the bar, toward the city, is a rather fine sand, with a little clay, covered in some places with 2 to 10 ft. of mud, while the outer slope of the bar consists chiefly of coarse sand or fine gravel. Excavation has disclosed the fact that much dumping of refuse material from the city has been surreptitiously done, and consequently that the pumps take out a great variety of material in addition to the principal classes just named, ranging from bones and scrap tin to paving blocks and a few modern projectiles. The total estimated amount of material to be removed is about 42,500,000 cu. yd., and the contractors undertook to take it out at a rate insuring completion in 1905. Their failure to accomplish this end prompted the construction of the two United States Government dredges, the Manhattan and the Atlantic, both of which have been on the work over a year.

A recent report made by Mr. Henry N. Babcock, to Col. W. L. Marshall, Corps of Engineers, U. S. A., under date of June 30 of the current year, sets forth the experience which has been gained with the two government dredges as to their rate of working, the cost of dredging, manner of working, and other features both of construction and operation of these interesting machines. The dredges, which are self-contained, sea-going vessels, holding their own dredged material until dumped in deep water, each have a carrying capacity of about 2,400 cu. yd., although a little less than that is ordinarily carried out to deep water per trip, this being a little less than the capacity of the contractors' dredge. The dredging pumps are, as usual, of the centrifugal type, and the pumping is done while the vessel is in motion at a speed of a mile or a mile and a half per hour against the current, and three or four miles per hour with the current.

Obviously, the most interesting results bear upon the rate of excavation and its cost. It is stated in Mr. Babcock's report that during the eleven months ending May 31, of the current year, the quantity removed was a little over three and a quarter million cubic yards at an actual average floating cost, so to speak (that is, including miscellaneous supplies, repairs and renewals), of 5.274 cents per cubic yard. About two-thirds of this cost is chargeable to pumping. The next item of expense, a little more than one-seventh of the total cost, is the cost of going to the dump; and the item third in amount is returning from the dump, the latter being about one-eighth of the total cost. When it is remem-

bered that the dredges stay at work in the channel until the weather becomes too stormy to go eight miles to sea to discharge the excavated material, the preceding results must be considered satisfactory. While large quantities of soft material are excavated and transported hydraulically in other localities under more favorable conditions, at much less cost, it must be admitted that these sea-working dredges are fully justifying their construction.

It would have been interesting if such items of mechanical operation as the velocity of water in the suction pipes required to move the different kinds of material had been determined and stated, as well as the paying percentage of weight of total material, including water, delivered by the pumps. The fact that paving stones and other similar heavy masses of material, including 3 and 5-in. shells, and pieces of heavy chain were taken through the pumps, illustrates forcibly the carrying capacity of a stream of water moving at no extraordinary speed. Indeed the blows of these water-borne projectiles of all varieties necessitated thickening of metal and the strengthening of some portion of the pump in order to avoid the breakages which occurred in the early stages of operation. These results have a significance beyond their association with harbor work, and indicate the efficient and economical use of hydraulic excavation, transportation and disposition of material in the building of dams and other similar structures which have already found a number of important applications.

In this particular connection, however, the closing paragraphs of Mr. Babcock's report set forth some important results. He states that the government dredges "are accomplishing more work and better work with a smaller and less costly plant than the contractors', and no one who has noted the work of the two plants under similar conditions doubts the superiority of the type of dredge in the government plant over the Liverpool type for work such as that in Ambrose Channel." He attributes these results, however, not "altogether to difference in kind of plant," but largely to a better and more efficient general organization and administration not only of plant but also of force. These government results certainly show, as he states, that such dredging ought to be done profitably at nine cents per cubic yard.

The Municipal Engineering Situation in Cuba.

The present moment is opportune for consideration of some of the phases of the engineering situation in Cuba. This country is especially interested in municipal sanitation and the progress which has been made along these lines since the Cubans assumed control of their own affairs. Much that is sensational and unfair has been written on this subject, and certain important considerations have been overlooked. Much work was done by the Americans during the intervention, in cleaning up the cities, improving the sewerage systems and paving the streets, but much remained undone. The Cubans have quickly grasped the importance of municipal cleanliness, and where the streets are sufficiently well paved to admit of it, they are kept cleaner in many Cuban cities than in some American cities not far distant from New York. Visitors to Havana have noted particularly the cleanliness of the Prado and the shopping district of Obispo and O'Reilly Sts., but they are not aware that a high degree of cleanliness exists in the streets of most of the towns and cities of the island. It is true that in the remoter portions of some of the cities, in what may be called the slums, particularly where the streets are unpaved, conditions

are not ideal, which is also true of a large number of our own cities and towns. In some respects the Cubans are more advanced, perhaps, than many of our own cities; for instance, the presence of stagnant, mosquito-breeding pools of water upon private property is prohibited by the municipal authorities, and the sanitary police are constantly on the lookout for such spots, sprinkling them with petroleum when found, and often fining the owner of the property.

In the more costly and permanent works of sanitation, such as the introduction of water supplies and complete modern sewer systems, progress has not been rapid since the intervention, but this does not arise from any indisposition on the part of the Cubans to carry out these works. It must be remembered that only five years ago Cuba started under an entirely new government, that that government had to settle its war debts and make large payments to its disbanded army; that it began business with practically nothing in its treasury, and of course without such credit as would enable it to readily finance its operations. The first duty and necessity of the government was to place itself in a better financial position. It must secure revenue, establish credit and place an issue of bonds to pay off its soldiers. This it has done most successfully, and its revenues have been so large that it has only been necessary to issue \$30,000,000 of bonds thus far, while there existed at the beginning of the present insurrection, a very large surplus in the treasury. During this brief period, the government has spent considerable sums in building permanent highways and has extended some aid to cities, for municipal improvement. There was so good a prospect that this government aid would be largely increased that unquestionably the temptation was strong for many of the cities to defer the building of water works and sewers until such aid was afforded, and this may have contributed somewhat to delay. Unquestionably the government was moving steadily forward to a position where it would have been able to contribute freely to public works.

Some of the cities showed promptly a disposition to finance their own improvements, but until the government credit was established municipal credit could not be good. During the intervention, plans had been prepared and a contract had been let for the sewerage and paving of Havana. When the Cubans took the reins of government Havana found little money in her treasury and an existing debt of from seven to eight million dollars, carrying rather high rates of interest. Plans had been made for a new municipal bond issue to the amount of about \$28,000,000, the proceeds to be applied in part to refunding the outstanding debt, and in part to sewerage, paving and improvement of the water works. This issue of bonds was awarded to bankers by the City Council, but the award was vetoed by the Mayor, the price being deemed inadequate. Havana is a city of over 250,000 inhabitants and is a wealthy sea port with large commerce. Notwithstanding the impression which prevails in this country, there has at no time been any disposition in Havana to delay needlessly the perfecting of its sewerage system or the paving of its streets. Indeed, as much has been done in this direction as it was possible to do without the assistance of the funds to be provided by the above-mentioned issue of bonds, and Havana stands ready to proceed with these works the moment that the bonds can be satisfactorily financed, which probably will be in the near future.

Santiago was sewerage during the intervention, but it did not have a supply of water adequate to make those sewers effective. At the present time new water works are being constructed, and when completed the city will be in good sanitary condition.

Cienfuegos is an important sugar port on the south coast with a fine harbor and an unusually fertile country in its vicinity. In one respect this has been the most progressive city on the island in that it has shown the least disposition to wait for government aid for its public works. An issue of \$3,080,000 in 5 per cent. bonds has been sold and contracts let for complete water works and a sewer system. Out of the proceeds of these bonds, the city also expects to build a municipal market and a slaughter house upon strictly sanitary lines. The city was largely paved with macadam by the Americans. Some of this pavement was permanent, but in other streets it was thin and of a temporary nature. All of these paved streets are kept remarkably clean, and there is not the least reason to assume any disposition on the part of the inhabitants to neglect the cleanliness of the city where conditions are such that cleanliness is possible. Of course until the sewers are built and the water supply introduced, entirely satisfactory conditions cannot be expected. It is interesting to know that at this time, when our own people are just beginning to doubt the wisdom of discharging crude sewage into tidal waters, the Cubans prohibit such discharge, and the sewage of Cienfuegos must be purified by the septic process before being discharged into the harbor, although the Bay of Jaqua is quite as large as the Bay of New York. All plans for municipal works have to be referred to the National Department of Public Works for approval. In this respect, also, the Cubans are fully up to our own practice.

Cardenas has recently municipalized its water works and will improve them promptly. A number of other towns and cities, such as Santa Clara and Camajuani, are contemplating similar improvements in the near future.

Havana has a very excellent and abundant supply of water from the springs at the Vento, delivered to the city by gravity. Its pressing need is for an intercepting sewer which will discharge the sewage far out at sea instead of into the harbor. The small bay, which receives but little fresh water from its tributaries, and which is connected with the sea by a restricted entrance, is ill-adapted to receive the large amount of sewage now discharged into it. The completion of this trunk sewer and the extension and improvement of the sewer system, together with a continuation of the work of paving streets and of the present sanitary regulations and inspection, should promptly place Havana in the front rank as to healthfulness. Indeed the general health of the city under Cuban rule has been good, and it does not deserve the suspicion under which it is held by many persons in this country, or the continual enforcement of the stringent quarantine regulations to which we have subjected it.

There has been, in some quarters, a disposition to clamor for the immediate execution of an entire system of municipal sanitation in the cities of Cuba, and those who have been responsible for this appear to have lost sight of the fact that if any of our own cities should be called upon to introduce water works and sewers and pave their streets at one operation, within a period of four or five years, it would be necessary for them greatly to strain their municipal credit in order to provide the funds. Some of our own cities, with almost double the population of Havana, are still without a system of sewers, and not five years, but twenty-five years or more, have passed since the time that they first prepared plans to improve these conditions. Recalling these facts, it seems most unreasonable that we should expect of the Cuban cities the instantaneous completion of all these costly works. Unquestionably it is important that this work of municipal sanitation should be pressed

forward; but to assume that the Cubans are unwilling to do this or are negligent because they have not accomplished everything within a short period of five years, is unwarranted. Should peace be promptly restored, we have every encouragement to believe that within a reasonable time sanitary conditions in the cities of Cuba will be highly satisfactory.

Notes and Comments.

THE STREAM GAUGINGS made in the past under the general direction of the U. S. Geological Survey have proved so valuable to engineers and the owners of industrial plants that the curtailment of this work through the neglect of Congress to appropriate funds for it is a serious matter. Any interruption of the records for more than a few months materially reduces the value of the data previously collected and to be obtained in future years. Few people except those directly concerned in water power and water supply subjects appreciate how much aid the gaugings have been in establishing industries and the development of irrigation systems. In the South and West particularly the records have been of great value. It is accordingly desirable that public and private interests throughout the country follow the example of the Civil Engineering Department of the University of Michigan and assist the Survey to keep up its gaugings until Congress makes suitable provisions for the work.

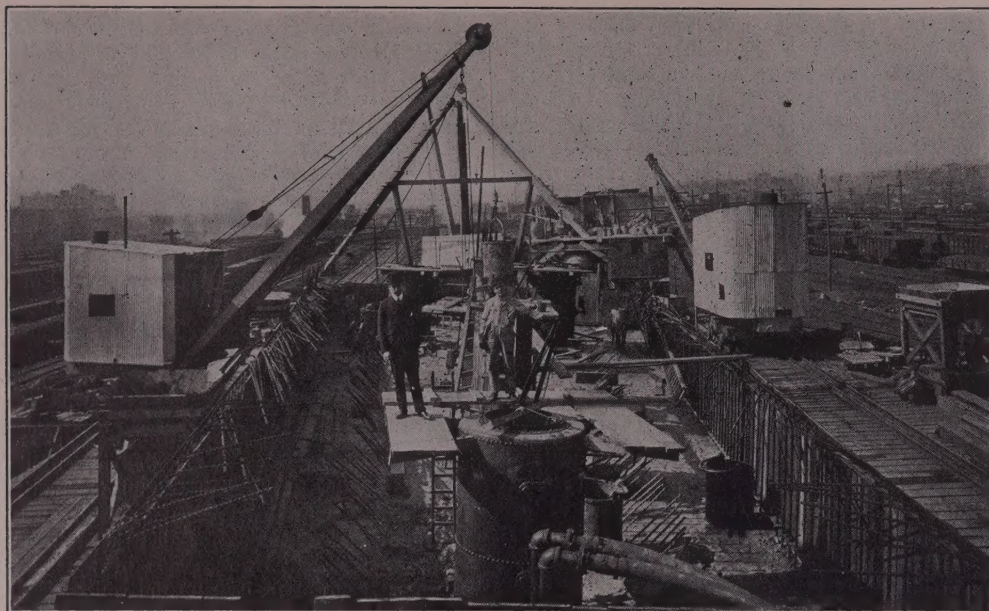
THE IMPROVEMENT OF ROADS in New York has progressed much farther than many people believe, and an examination of the book referred to by State Engineer Van Alstyne in his letter in another column affords proof of the fact that the people of the Empire State are alive to the importance of this work. The statement that two-thirds of the towns in the State have abandoned the old and useless system of working out road taxes and voluntarily adopted the money system tells a story of deep interest to those who realize what good roads mean to rural communities. It indicates that the day is past when any old line of mud, ruts and stones is considered a road, and heralds the approach of the time when road engineering will be recognized as essential in the construction and maintenance of highways. The official publications of the New Jersey Highway Commissioner and of the Massachusetts State Highway Commission have done much to awaken sympathy and secure support for road improvements in those States, and the campaign of publicity of the State Engineer of New York is, therefore, fully justified by experience elsewhere, and may be confidently expected to result in the construction of the networks of good roads mentioned by Mr. Van Alstyne.

THE EXTENSION OF AMERICAN TRADE into South America is now receiving the attention of so many manufacturers of engineering machinery and supplies, that the letter elsewhere in this issue from Mr. W. J. Johnston, publisher of the "American Exporter," deserves some comment. It mentions two factors restricting our export business to Brazil, which are the cause of frequent adverse criticism elsewhere, refusal to extend customary credits and failure to meet local requirements concerning minor details. The seeming inability of American manufacturers to appreciate that business can only be built up in another country by adopting the business customs of that country is surprising. The foreign representative of an American manufacturer has a sufficiently difficult task in introducing new machinery without being hampered by rules regarding credits which

are perfectly proper in the United States, but are little, if anything, short of insulting to reputable firms of other countries, where a long time is given regularly for meeting obligations. The second obstacle to the extension of our trade is the refusal of American manufacturers to deviate at all from their standard methods. Standards are highly desirable, but there is such a thing as a slavish adherence to them which is productive of no good and results in dry rot in the business affected by it. A man who hunts for foreign trade must make concessions in his product as well as his business methods, which is the substance of Mr. Johnston's advice.

WATER PURIFICATION IN THE HOUSEHOLD is recommended by Major C. E. Gillette, chief of the Bureau of Water Purification of Philadelphia, his method being somewhat unusual as is shown by the following transcript of his suggestions: "First, Take exactly two gallons of water. If the water is not clear, beat up the white of one egg and add it to the water before boiling. This will gather up every particle of foreign matter in the water and carry it to the bottom. The water should be brought to a brisk boil and then stood aside to cool and settle. Second, Pour off the clear water and stir to it a level teaspoonful of bicarbonate of soda. Then stir in two-thirds of a teaspoonful of hydrochloric acid. This will make the water perfectly safe, sparkling and refreshing without any flat taste." The popular opinion concerning this advice, to judge from the local newspapers, seems to be that it is an inadequate substitute for filtered water, which would have been delivered to all parts of the city in all probability before this time had no cry of fraud been raised to stop the work. Up to now the only suit brought by the city authorities to prove these charges of graft resulted in the acquittal of the party accused; one of the leading contractors interested in the work, tired of waiting for the city to bring the suit against him which has been threatened for such a long time, has at last brought suit himself against the city for several millions damages.

CONCRETE CONSTRUCTION IN BUILDINGS in New York has been threatened with a serious handicap by an agreement recently made between the master masons and the bricklayers' union, under which all the work of placing concrete is to be done by bricklayers. One of the great merits of concrete work about buildings has been that it was done by unskilled labor. The molds had to be prepared and set by skilled men, but the concrete work itself could be done by the most ignorant class of laborers provided they worked under good supervision. Under the new agreement it will be necessary to pay at least \$4.80 per day per man for this simple work, and in consequence the cost of concrete construction in buildings will be materially increased. Fortunately the very conditions of the new agreement will doubtless lead in time to its abandonment as impracticable. The large amount of concrete in buildings will demand the services of more bricklayers than can be furnished by the union, yet it is safe to say that the skilled men now in that organization will not admit to its ranks unskilled men for the purpose of furnishing men for concrete work alone. This condition cannot last very long. Moreover how far the affiliations between the unions in the building trades will go to help the bricklayers make a strong fight for the agreement is a little uncertain, because a concrete building gives employment to an unusually large number of carpenters in making and setting forms, and any reduction in concrete construction accordingly affects adversely the carpenters of the city.



Handling Excavated Material Through Air Locks. Feb. 24.

A REINFORCED CONCRETE TUNNEL CAISSON.—I.

Calculation and Design.—An important part of the general subway railroad system of New York is that now under construction by the Hudson Companies. This work, as at present planned, consists of a double-track subway extending south from a terminal station at 33d St. and Sixth Ave., with several stations on Sixth Ave., and west from a terminal station at Astor Pl., to a junction at the intersection of Christopher St., Sixth Ave. and 9th St.; thence by two single-track tunnels (one for each direction of traffic) westward, with two stations on Christopher St., under the Hudson River, reaching the Jersey shore at the foot of 15th St., Jersey City. From this point there will extend a double line of tunnels (one for each direction) by a long swing to a Hoboken terminal near the Delaware, Lackawanna & Western R. R. passenger terminal, and a double line of tunnels southward to terminals at the Erie R. R. station in Jersey City, and to a station at the Pennsylvania Railroad's Jersey City terminal. From the Pennsylvania terminal two tunnels are being built under the river to the terminal buildings now being constructed on Church St. between Cortlandt and Fulton Sts., in New York City.

The main feature of this work is the river tunnels, the land portion of the work being incidental to the collection of passengers at the terminals located where traffic will originate, the object being to substitute a tunnel ride for a ferry ride. This tunnel system was started in 1874, when a shaft was commenced at the foot of 15th St., Jersey City. Tunnel construction from this shaft eastward and from a shaft at the foot of Morton St., New York, westward was carried on during the years 1880 to 1882, when cessation of work was caused by lack of funds. The work built at that time was brick tunnel, the walls being of about 2 ft. 6 in. thickness, with a thin sheet iron lining outside. This tunnel was driven by the pilot method and a total of about 2,000 ft. of the northern tunnel and of 600 ft. of the southern tunnel were finished from the New Jersey shaft eastward.

In 1890 the construction work was again started up by S. Pearson & Sons, contractors. This time the shield method and cast-iron rings were used. In 1891 the work was again abandoned on account of lack of funds, after the northern tunnel had been extended 1,700 ft. nearer New York.

At a point 3,700 ft. east of the New Jersey

shaft the Hudson Companies in 1902 found the shield abandoned in 1891 in good condition, and with it completed the tunnel to the Morton St., New York shaft, in March, 1904. On Sept. 22, 1905, the Hudson Companies also completed the southern tunnel, from end to end with the circular shield and east iron ring method, abandoning the 600 ft. of brick tunnel built in 1880-1882.

The river tunnel from the foot of Morton St., New York, to the foot of 15th St., Jersey City, has a length of about 5,700 ft. between shore shafts and a maximum depth of 102 ft. below mean tide level. Its two single-track tubes have external diameters of about 19½ ft. and 16½ ft. for the north and south lines, respectively.

They have been built under dangerous and difficult conditions, and their successful operation has been accomplished by some of the most courageous and persistent engineering construction on record. An outline of the history of the project and an illustration of the principal features of the method and plant finally used in its successful completion was published in *The Engineering Record* of July 25, 1903.

At the New Jersey end both river tubes will be connected, as before stated, with a line parallel with the river and extending from Hoboken to another pair of tunnels crossing the river opposite the Pennsylvania R. R. terminal. The connection between the river tubes and this line will be made in both directions, thus forming a Y junction, and in order to avoid the grade crossing that would result if this were made in the ordinary way, the tracks for traffic in different directions are placed on different levels 24½ ft. apart vertically. This combination of curved tunnels at different levels involved a very complicated construction in the soft wet ground more than 80 ft. below the surface. To build it by ordinary tunneling methods was manifestly so difficult as to be almost impossible.

The tunnels forming the several legs of this Y junction are being built by the shield method, but it is evident that the portion of the tunnel from the points of switches to the point where the divergence in the tracks is sufficient to admit of the construction of two separate tubes could not be built by the shield method, but would have to be built by other means.

A short section of the structure where all of the lines converge or intersect was therefore isolated from the rest for construction purposes and was considered as a solid mass of masonry

pierced horizontally by an upper and lower chamber in which the connections are made with the land and river tunnels. It was manifestly impossible to build this work in open excavation or by ordinary tunnel methods; therefore it was determined to build it as a complete structure above ground and sink it bodily to the required position, where connections could be made underground with tunnels driven in the regular manner.

This method required that the structure be built as a pneumatic caisson of dimensions sufficient to cover the gap that could not be constructed by the shield method. The location and horizontal outline of this caisson is marked Caisson No. 1, on the accompanying general map, which shows the subterranean construction adjacent to the New Jersey shaft of the river tunnels. This map also shows the Y junction formed by the branches divergent from the caisson which unite it with the main lines parallel to the river, thus forming a triangle about 600 ft. by 1,400 ft. The construction at the other vertices would also be difficult to make by ordinary methods, and therefore the method which has proved eminently satisfactory at Caisson No. 1, has been approved for them and Caisson No. 2 at the north end of the triangle is under process of construction, and No. 3, not here indicated, will later be built at the south end.

The preliminary studies for the caisson involved the use of steel walls, roof and girders and two interior floors above the working chamber dividing it into first and second stories for the connections of the different tubes. As the roof must support an extremely heavy surcharge of earth and water, the girders required to sustain this across the long span necessitated by the two tracks in the caisson resulted in the use of enormously heavy plate girders in the roof. The other stresses to which the caisson was subjected required great strength in all parts of the caisson, so that the estimated weight of steel amounted to about 1,750,000 lb. It was proposed to fill the working chamber with concrete, which, together with that used in other parts of the caisson, was estimated at about 1,600 cu. yd., making an unusually heavy and expensive structure.

Prices and times of delivery were obtained on the structural steel for this design and the cost was found to be so great and time required for its fabrication and erection on the site so long, that further studies were undertaken to see if the cost and time required for construction could not be diminished. These studies were made along two lines, first to see if the structural steel framework in the original design could not be simplified and cheapened by the introduction of kneebraces and a reduction in the depth of the girders, and second, to abandon the structural steel framework and to construct the caisson of reinforced concrete. After a comparative study of these two plans, it was decided to adopt the reinforced concrete design, the principal reasons leading to this decision being as follows:

First, The saving in time due to the fact that all materials required for the reinforced concrete construction could be quickly obtained and construction started by the company with ordinary labor, which with the structural steel design work could not be commenced until the structure was designed in great detail, fabricated and assembled, all of which it would be necessary to do by contract and would require a much longer period of time.

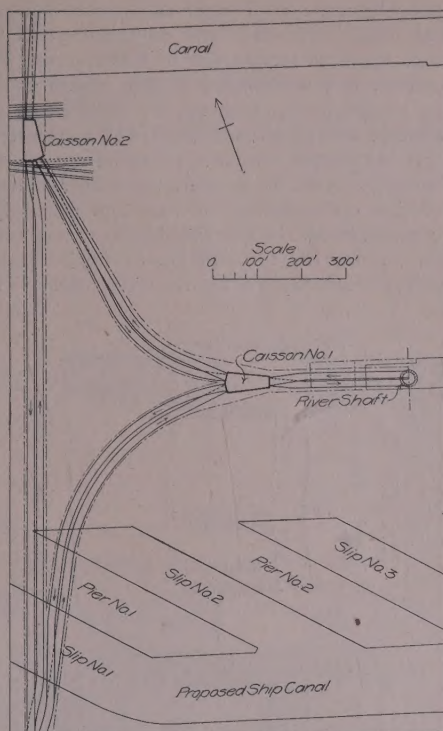
Second, In order to sink the structural steel caisson it would be necessary to add considerable weight in addition to the steel in order to overcome the buoyancy due to its displacement. The best way to increase the weight was found to be to fill in between and around the structural steel

girders with concrete, particularly as this also preserved them from corrosion and the amount of this concrete was found to be nearly as great as in the concrete-steel design. It, therefore, seemed more logical as a certain amount of concrete was common to both plans, instead of merely making use of its dead weight and its preservative properties, to take advantage, also, of its compressive strength and to design the structure so that it would only require a small amount of steel to give it the necessary tensile strength.

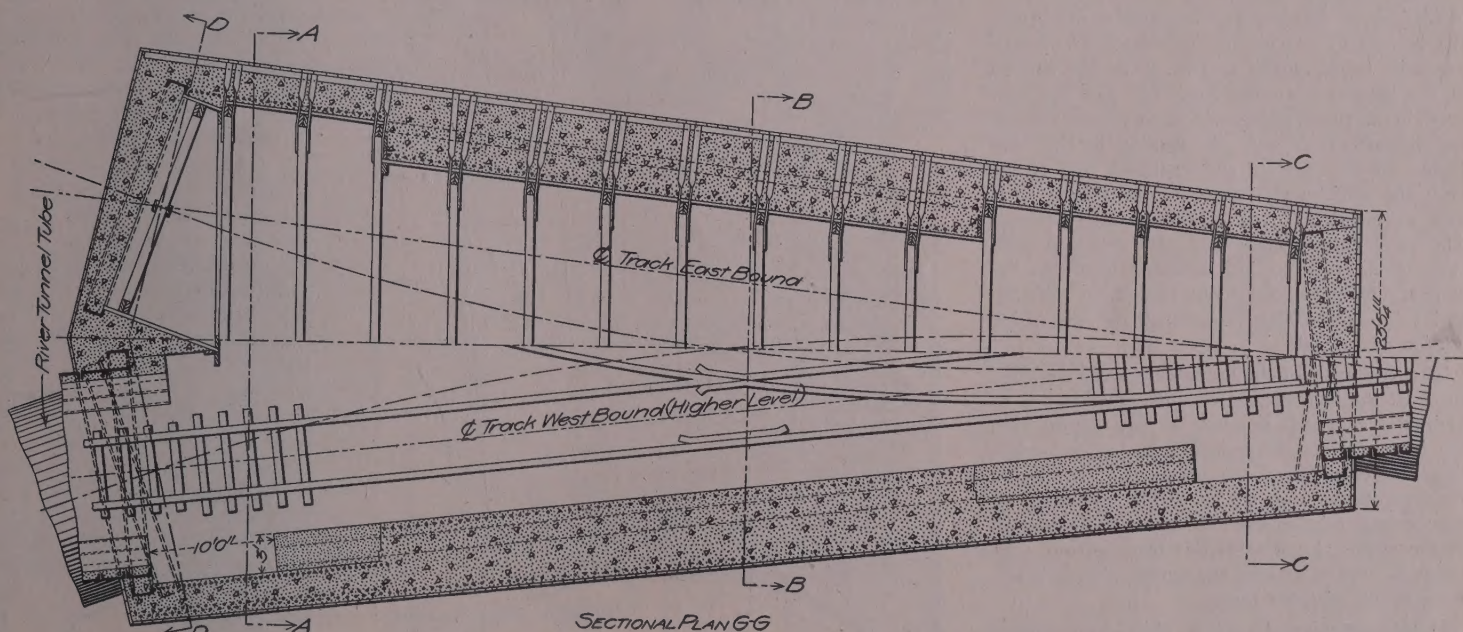
Third, In the structural steel design it would be necessary to make the bottom floor of the caisson of deep steel girders and to place the working chamber of the caisson below this floor, the same to be filled with concrete after the sinking, while in the concrete steel design the whole of the space for the lower tracks could be used as a working chamber and sealed by an invert when sunk to its final position, thus giving room to the workmen and saving several feet of excavation.

Fourth, An estimated saving of \$100,000 per caisson.

This design was adopted, the caisson was built and has now been successfully sunk to final position. The caisson is located in the Delaware, Lackawanna & Western R. R. yards, and adjacent to their tracks, which are likely to be run over it in the future. It is approximately trapezoidal in plan, about 101 ft. long and from $23\frac{1}{2}$ to 46 ft. wide.



Location of Caissons.



Half Plans of Tracks and Centering.

The extreme height above the cutting is about $51\frac{1}{2}$ ft. and the total weight of the permanent structure is about 13,300,000 lb. It was assumed that the design must provide strength to resist the stress in two principal conditions, namely, that of the completed structure, in final position, and that of the sinking period, and careful analyses and computations were made to determine the stresses under these conditions. As the forms and centers and the air pressure were not removed until after the sinking was completed, it was assumed that the maximum stresses, excepting the undetermined ones due to possible distortion during sinking, were not developed until after it reached its final position. In order to compute the stress in the first case, it was assumed that the load on the roof was due to the earth filling plus the hydrostatic pressure, without considering the possibility of trains crossing it in the railroad yard, although allowance was made for the future elevation of 7 ft. in the surface of the ground. The weights per cubic foot of the principal materials were assumed at 60 lb. for

water, 160 lb. for concrete, 40 lb. for earth below water level and 100 lb. for earth above water level. It was assumed that the resultant earth and water pressure produced a horizontal force of 90 lb. per square foot per foot of depth. The external forces acting upward on the invert were assumed to be the hydrostatic pressure plus the vertical reactions. Diagrams of these forces were made in vertical transverse planes at the large end of the caisson, in the middle and at the small end, and graphic analyses demonstrated that the resultants were horizontal forces of 227,000 lb., 225,500 lb. and 224,000 lb. per lineal foot, respectively. These resultants required opposing horizontal forces of the same total amount applied at the crowns and inverts of the tunnel arches. These forces were not sufficient to maintain the arches in equilibrium, and the difference between them and the necessary thrust was provided for by steel reinforcement bars proportioned for this service. These forces produced maximum unit stresses ranged from 168 lb. in the intermediate arch at the small

end to 517 lb. in the invert at the large end for compression of the concrete, and from 5,700 lb. in the upper arch at the intermediate section to 32,000 lb. in the invert at the large end for tension in the steel. This large stress was considered permissible because, as the preliminary borings indicating rock at this end, it was believed that the theoretical conditions assumed would not be developed, and that the invert would only have to stand hydrostatic pressure.

The stresses developed during the sinking of the caisson were determined by three similar graphical diagrams taken in the same planes and give the resultants for three different conditions, namely, without internal air pressure, with pressure in the upper chamber only and with pressure in both chambers. The analyses of these stresses show that the resultant external force varied from 36,000 lb. at the small end of the caisson when both chambers were under air pressure to 263,000 lb. at the large end of the caisson when neither chamber was under air pressure. The effect of this result tending so nearly to balance the external force and combined with the strength of the centering, indicated that the stresses due to external force in the concrete during sinking were negligible.

In order to assume some reasonable value for the indeterminate stresses due to distortion and unequal settlement in the caisson during the sinking, the caisson was considered as a longi-

tudinal girder with a bearing $12\frac{1}{2}$ ft. long at each end. Under these conditions if the material was excavated clear of the cutting edge between bearings, the caisson had sufficient strength to support its own weight. If considered as a double cantilever girder supported on a bearing 25 ft. long at the middle with the cutting edges clear at both ends, it had calculated strength to support only one-third of its weight. It was therefore required that during the first 30 or 40 ft. of sinking the caisson should be partially supported by blocking so as to prevent the whole weight from resting on the cutting edge and to assist in maintaining its level until the air pressure and skin friction balanced the weight. It was also required to prevent the possibility of the caisson bearing too much either at the ends or in the middle. Additional precautions were also taken to maintain the caisson level and to prevent its sinking below the final position.

The caisson, although of a somewhat complicated design, is symmetrical about the longitudi-

When sunk, the bottom of the lower chamber of the caisson was open, enabling it to be used as an excavating chamber, and both ends were closed with concrete bulkheads integral with the permanent walls, thus making the structure continuous and distributing all stresses above the cutting edge.

After the caisson was sunk to position, it was completed by building an invert similar to the roof arch enclosing the bottom of the lower chamber and serving as a floor for it and to resist exterior upward pressure. Additional concrete lining was also built to face the inner surface of the side walls, thus completing the construction shown in the accompanying sections which was finally modified by the removal of the concrete in the end walls to admit of the shields being driven through in constructing the tunnel tubes. At these places, the concrete was reinforced by single segmental cast-iron rings concentric with the tunnel tubes, but having a diameter about 3 ft. greater than the tunnel segments. When the connections with the tunnels are made, the concrete 3 ft. thick enclosed by these rings will be blasted out, making an open-

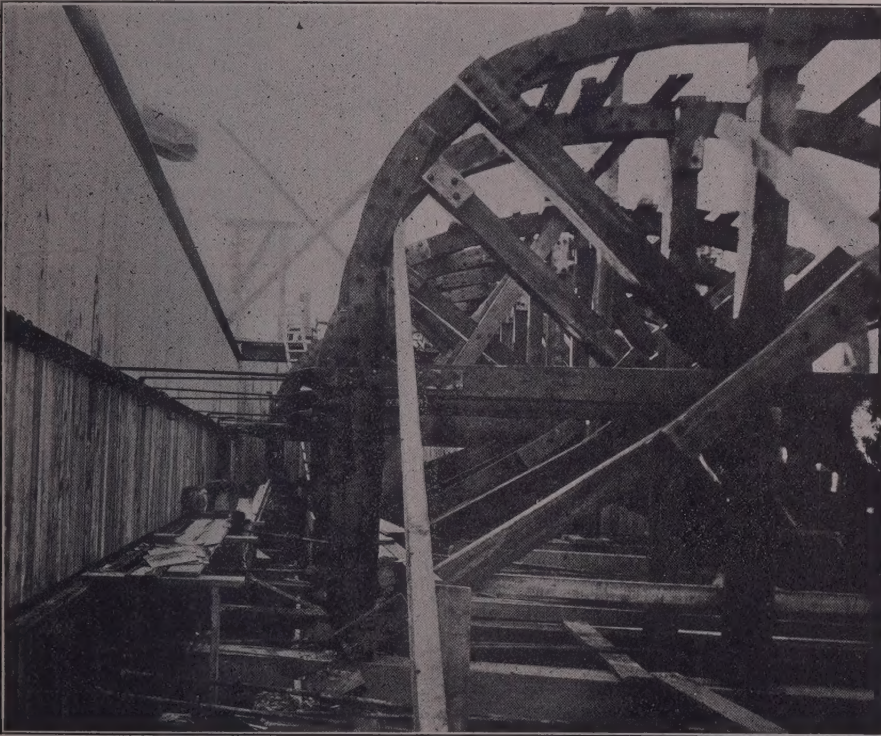
the exposed concrete, and as it was assumed that any leakage through the mass would soon be corrected by mud and sedimentary matter percolating through with the water, no waterproofing was provided.

The area of the exterior surface of the caisson walls is 12,486 sq. ft., and the horizontal area inside the cutting edge 3,435 sq. ft. The total exterior volume is 165,878 cu. ft. and the volumes of the upper and inner chambers are 45,453 cu. ft. and 52,988 cu. ft. respectively, leaving a net volume of 67,437 ft. for the material used in its construction of which 64,741 cu. ft. or 3,000 cu. yd. was estimated as concrete. There were also 160,000 lb. of twisted rods, 61,200 lb. of steel rails, 78,000 lb. of cast-iron tunnel rings and 108,200 lb. of structural steel in the cutting edges and in the walls above them, thus making together with about 3,000 ft. of timber, board measure, built into it for the caisson and 4,000 ft. in the forms and centers, a total weight of 10,710,000 lb. available for sinking it. Filling the upper chamber with water weighing 2,625,000 lb. gave a total sinking weight exclusive of other ballast of 13,335,000 lb. as compared with the

sary for sinking the caisson to its final position was estimated at 10,700 cu. yd., of which 4,500 cu. yd. was to be replaced over the caisson roof. The careful analysis of conditions and stresses, together with the complete estimates and calculations above mentioned enabled the designers and constructors to provide thoroughly in advance for the execution of the work, and were fully justified by the rapidity and success with which the caisson was built and sunk and the economy and safety with which the work was accomplished in comparison with that likely to be attained by any other method.

The tunnel construction is being conducted by the Hudson Companies, and the design, construction and sinking of the caissons were carried out under the personal direction of Mr. Charles M. Jacobs, chief engineer; Mr. J. V. Davies, deputy chief engineer, and Mr. C. D. Snyder, principal assistant engineer. The construction and sinking of the caisson was in charge of Mr. R. S. Courtney, works manager; Mr. W. M. Torrance, superintendent of concrete construction, superintended the caisson construction after having previously worked out the design and made the necessary computations. The sinking was done under the direction of Mr. Samuel Mattson, superintendent of caissons, who also made valuable suggestions as to details of the design.

(To be Continued.)



Details of Lapped Centering.

ing large enough to allow the passage of the shield and the placing of the tunnel tubes. The large rings will remain permanently imbedded in the concrete joint formed between the tunnel and caisson, and will have served to limit the opening made in the caisson walls and to protect the latter from injury beyond them. It was at first proposed to provide heavy timber bulkheads in the ends of the caisson, but they were eventually replaced by the construction above described, which it was considered could be more satisfactorily removed in making the tunnel connection.

The 1:2:4 concrete was made with Giant Portland cement, sand and 1½-in. run-of-crusher granite. All of the reinforcement was made with twisted square steel rods except where rails were used in the roof of the upper chamber, as before mentioned, and in the three horizontal tiers parallel and close to the cutting edge. In the latter case, the feet of the side walls were strengthened by eleven 80-lb. rails with lap joints about 10 ft. long. Care was taken to work the stones back from the inner faces of the moulds so as to form a smooth surface for

displacement of 10,450,000 lb. With the friction assumed at 200 lb. per square foot of the vertical exterior surface, it was calculated that the caisson would sink under its own weight until the cutting edge was at a depth of 40 ft. below the surface of the ground. Assuming a skin friction of 400 lb., this depth would be reduced to 33.4 ft. With the upper chamber filled with water, the cutting edge would sink to 49½ ft. and 41½ ft. respectively under skin friction of 200 lb. and 400 lb. per square inch. In order to sink the caisson 1 ft. farther, additional loads of 270,000 lb. and 331,725 lb. were computed to be necessary when skin friction was assumed at 200 lb. and at 400 lb. per square foot respectively. Assuming a skin friction at 200 lb. and at 400 lb. the corresponding extraneous loads required to sink the cutting edge to its final position 84 ft. below the surface or 77.2 ft. below mean tide were respectively 6,133,850 lb. and 8,681,050 lb., equivalent to depths of earth of 17 ft. and of 24 ft. on top of the caisson roof, amounts which were easily available since the final position of the caisson roof is 33 ft. below the surface of the ground. The total amount of excavation neces-

AN ADVERTISEMENT FOR ENGINEERING SERVICES, which is unique in its entire lack of appreciation of proper methods, reads as follows: "Proposals will be received from engineers on the 9th day of October, A. D. 1906, for making plans and specification of a reservoir for the improved water supply of the City of Ada, I. T., and for other improvements to the water system of said city. Each engineer will be required to submit complete plans and specifications for the work to be done, accompanied with their proposal to superintend the work, and their estimate in detail of the cost of the work; said estimate shall fully cover the cost of construction work and engineering services. Each engineer shall furnish evidence from some solvent surety company that in the event that contractors bidding on the work under his plans and specifications, shall result in no responsible bids for the construction of work at or below said estimated cost, that the bonding company will make bond for said engineer in the sum of not less than Ten Thousand (\$10,000) Dollars, guaranteeing the cost of said work shall not exceed the amount of said engineer's estimate. Engineers entering this competition shall so draw their plans and specifications that the City may purchase their material direct from the manufacturers, and that the contractor shall bid in the assembling and construction of those materials into the proposed work. Each competitive plans and specifications shall bear the approval of the Oklahoma Board of Fire Underwriters. The City will employ that Engineer whose plans and specifications and proposal to do the work shall appear to be the most advantageous to the City of Ada, reserving the right to reject any and all proposals; it being distinctly understood that the City will not be indebted to any competing engineer except one who may be employed to superintend the work." The good people of Ada, I. T., would probably not think of engaging legal counsel or medical advice in this way, and their mistake lies in not recognizing that an engineer's services to his client are of the same character as a lawyer's or a physician's. Engineering advice is not farm produce, to be sold by sample, or a manufactured product bought under guaranty, and the community which does not act on this knowledge is likely to meet with much misfortune.

A Large Reinforced-Concrete Standpipe.

A reinforced-concrete standpipe, 50 ft. in diameter, 106 ft. high from the inside of the bottom of the tank to the top of the cornice and with a capacity of 1,500,000 gal., has been completed and is in service in the water-works system of Attleboro, Mass. The standpipe was described in a paper presented at the recent meeting of the New England Water Works Association, by Mr. George H. Snell, water commissioner and superintendent of water works of Attleboro. The following description of the design and construction of the tank and of the successful results obtained with it in service, has been prepared from this paper and from the discussion which was presented at the time upon it. This discussion was offered by Mr. F. A. Barbour, consulting engineer, of Boston, Mass., who supervised the design and construction of the standpipe, and by Mr. Leonard C. Wason, of the Aberthaw Construction Co., of Boston, Mass., which company made the details of the concrete design and carried on the construction.

The pumping station of the Attleboro water works system is about 4 miles from the central part of the town, and only a single force main connects the station with the distribution system. The storage capacity formerly available was furnished by a wrought-iron standpipe 30 ft. in diameter and 125 ft. high, with a total capacity of 661,000 gal., or about the daily consumption. The top of this standpipe was at about the same elevation as the grade of the business streets in the business section of the town. Under these conditions direct pumping was necessary during fires and the water supply was at all times entirely dependent on the single force main. The commissioners of water works desired, if possible, to build a storage of some type to hold 3,000,000 gal., in order to relieve the situation. A hill on a direct line between the pumping station and the center of the town and rising 125 ft. above the street grade at the latter point was, fortunately, the only available location. A reservoir on this site which would supply sufficient pressure, was impossible, so a standpipe was the only alternative. The decision was made that a standpipe of steel or of reinforced-concrete holding 3,000,000 gal. could not be built with safety, but that one 100 ft. high and 50 ft. in diameter, holding 1,500,000 gal. would be as large as practicable to produce the desired pressure.

The water supply of Attleboro, although excellent for both domestic and manufacturing purposes, contains carbonic oxide in sufficient quantity to attack wrought iron or steel, but practically without effect on cast iron. The experience gained with the former standpipe, which was erected in 1890, seemed to indicate that the life of such a structure when subjected to the Attleboro water could be safely estimated at not less than 20 years. It was also estimated that nearly 2 tons of rust were removed from the old standpipe when it was cleaned annually, in addition to the quantity finding its way into the distribution mains and service connections. This iron had caused much annoyance in domestic use and a great amount of difficulty with galvanized iron pipe, so that all service pipes installed during the past six years have been lined with cement. This quality of the water, together with the difficulty of rolling steel plates of the thickness required toward the bottom by the height of standpipe proposed, necessitated some other type of construction than steel plates.

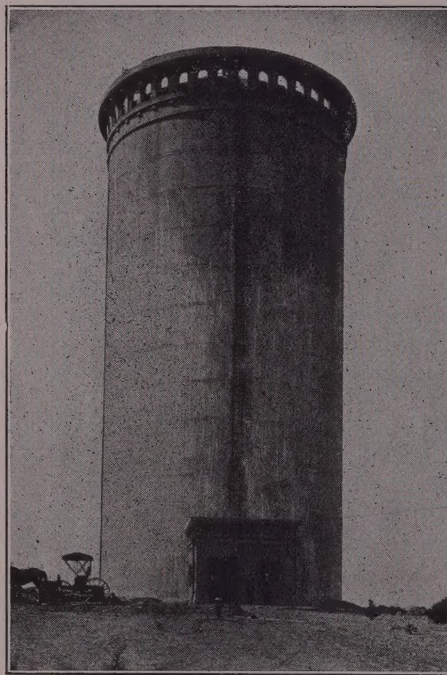
At the time the standpipe was contemplated a reinforced-concrete standpipe 20 ft. in diameter and 40 ft. high, had been built at Fort Revere, in Boston, and a second one, 15 ft. in diameter and 85 ft. high, at New Milford, Ohio. Both of

these structures are said to have given perfect satisfaction. Accordingly proposals were invited for a reinforced-concrete standpipe for Attleboro, and estimates were obtained on a steel structure of the same dimensions.

Design and Materials.—With the desire to limit the bidders to specialists in reinforced-concrete work and to permit each bidder to use his special type of reinforcement as appeared to him to be necessary, and in the best way, bidders were required to submit detailed plans and specifications of the system of reinforcement, the method of construction, the water-proofing, and to guarantee the structure, in point of safety and water-tightness, under penalty of a bond of \$10,000, for one year after date of acceptance.

General plans, showing the outward appearance of the tank, the pipe connections and the gate house, and general specifications, were prepared by the engineer. A clause of these specifications reads as follows:

"And the general intention of these specifications is to specify the size, outward appearance and the quality of the material and method of its incorporation in the work in so far as the material may affect the life of the standpipe be-



Reinforced Concrete Standpipe.

yond the period for which the contractor is held responsible—leaving to the contractor the detailed design and choice of type of steel reinforcement and requiring him to guarantee the safety of the structure and the absence of leakage for the term of one year.

"It is the intention of the Water Board to consider proposals on the basis of cost and on the relative value of the bids as presented from the standpoints of strength and probable absence of leakage as indicated by the specifications describing the proposed method of construction as submitted by the bidder."

The general specifications describe the quality of the cement which should be used, requiring a tensile strength of 185 lb. in 24 hr., 600 lb. in 7 days, and 175 lb. in 7 days when mixed 1 part cement, 3 parts sand, together with the further requirement that the cement mixed 1 part cement and 3 parts sand shall develop a strength in 28 days 15 per cent. in excess of that shown in 7 days. Fineness was to be such that not more than 5 per cent. would be retained on a sieve with 100 meshes per inch and not more than 24 per cent. on a sieve with 200 meshes per inch. The standard tests for soundness, included the cold

test and also the exhilarated test in-boiling water for three hours.

Five proposals were received, the total price for the standpipe ranging from \$33,679 to \$75,000. A brief summary of these proposals is as follows:

The lowest proposal involved the use of $1\frac{1}{4} \times \frac{1}{4}$ -in. T-bars as the horizontal reinforcement, with vertical bars 18 in. apart in the walls; no steel in the bottom, horizontal reinforcement with a working stress of 13,000 to 19,000 lb. per inch, bottom to be constructed of concrete, sides of cement mortar mixed 1 part cement and 3 parts sand; horizontal rods joined by soft wire, but principal reliance on the bonding of the concrete. Inside plastered with $\frac{1}{2}$ -in. coat, 1 part cement, 1 part sand and $\frac{1}{2}$ part lime paste.

The proposal of the Aberthaw Construction Co., which was accepted, was based on the use of square, cold twisted bars, from $\frac{1}{4}$ to $1\frac{1}{4}$ in. in dimensions, the working stress varying from 13,500 lb. per square inch at the bottom to 8,000 lb. per square inch at the top; the horizontal bars being placed in three rows at the bottom, two rows half way up and one row at the top; $\frac{5}{8}$ -in. square bars being used vertically, 3 ft. apart, grill work of steel in bottom for temperature; foundations to be constructed of 1 part cement, 3 parts sand and 6 parts stone. The water-proof work to be mixed 1 part cement, 2 parts sand and 4 parts stone, or so as to give an excess of 10 per cent. cement over voids in sand. Inside surface to be plastered with a special mixture of cement, sand, glue and alum.

Another proposal was based on the use of $\frac{1}{4}$ to $1\frac{1}{4}$ -in. Thatcher corrugated bars; this reinforcement being used with a working stress of 15,600 lb. per square inch. Vertical bars $\frac{5}{8}$ in. in dimensions were to be spaced 9 in. apart for 80 ft. up and 18 in. apart for the remainder of the height of the tank. Concrete in walls to be mixed 1 part cement, $2\frac{1}{2}$ parts sand and $4\frac{1}{2}$ parts stone; no plastering proposed for walls but the use of castile soap and alum applied in three coats, to be given the wall after completion.

A fourth proposal contemplated the reinforcement of the tank by $\frac{5}{8}$ to $1\frac{1}{4}$ -in. Johnson corrugated bars, used with a working stress of 15,800 lb. per square inch; vertical bars, $\frac{1}{2}$ in. square, placed 12 in. apart on centers; concrete in bottom mixed 1 part cement, 3 parts sand and $7\frac{1}{2}$ parts stone; concrete in walls 1 part cement, 2 parts sand and 4 parts stone. The noticeable feature of this proposal was the inside and outside facing of the concrete walls with a course of brick and the placing of a layer of water-proofing between the inner brickwork and the concrete.

The fifth proposal considered a mixture of 1 part cement, $1\frac{1}{2}$ parts sand and 3 parts stone for the lower 50 ft. and 1 part cement, 2 parts sand and 4 parts stone for the rest of the wall. The reinforcement of Thatcher bars was to be used with a working stress of 14,000 to 19,000 lb. per square inch; plaster to consist of $2\frac{1}{2}$ coats of 1:1 mortar, containing soap and alum and a coating consisting of lye, alum and cement was proposed for the waterproofing of the tank.

It is to be noted that in the various proposals the working stress varied from 13,500 to 19,000 lb. per square inch; that the concrete varied from a mixture of 1:2 $\frac{1}{2}$:5 to a mortar of 1 part cement to 3 parts sand, and that the waterproofing in all cases contemplated some method of surface treatment on the interior face of the wall.

An estimate received on a steel standpipe of relative size stated a price of \$37,500 or \$3,138 more than the contract price of plan accepted for a reinforced-concrete structure. In addition to the saving in first cost thus obtained the estimated life of a steel standpipe supplied with the Attleboro water, is 20 years, with an annual expense of \$400 for maintenance, while the life of

the reinforced-concrete structure is considered to be indefinite and it is not expected to require any maintenance.

The general dimensions of the standpipe as it has been constructed have already been noted. An excellent foundation of hardpan and boulders was secured. The walls of the standpipe are 18 in. thick at the bottom and 8 in. thick at the top. A roof of Guastavino tile is provided. An inlet pipe rises to an elevation of 40 ft. above the bottom of the tank; check valves, compelling the water to enter through this pipe and leave through a 24-in. pipe at the bottom of the tank, ensure circulation. Below the cornice which surrounds the walls ornamental pendants of concrete are placed. Just above a belt course and back of these pendants openings were made in

with a coefficient uniformity of 5.6. The stone used, for the most part taken from the immediate vicinity of the work, was of excellent qual-

TABLE 1.—RESULTS OF CEMENT TESTS.

	Tensile strength—					Condition of test pit.		Fineness.	
	Neat.					3 hr. in steam.	28 da. in water.	Percentage retained on 200 mesh sieve	100 mesh.
	24 hr.	7 d.	28 d.	1 part cement, 3 parts sand.	7 d.	28 d.			
Average	373	594	689		266	358		14.5	1.0
Maximum	474	697	793		339	422	Perfect	15.8	1.8
Minimum	203	478	582		199	281		12.3	.5

ity, with an average specific gravity of about 2.68. The stone was crushed and passed through screens with openings varying from $\frac{1}{4}$ to $1\frac{1}{2}$ in. diame-

extent, occur, he believes, in the discharge of most mechanical mixers and the final character of the concrete for waterproof work is determined by the maintenance of a thorough mixture up to the actual placing of the concrete in the walls and the required degree of care in ramming and joggling the mass to place in and around the walls.

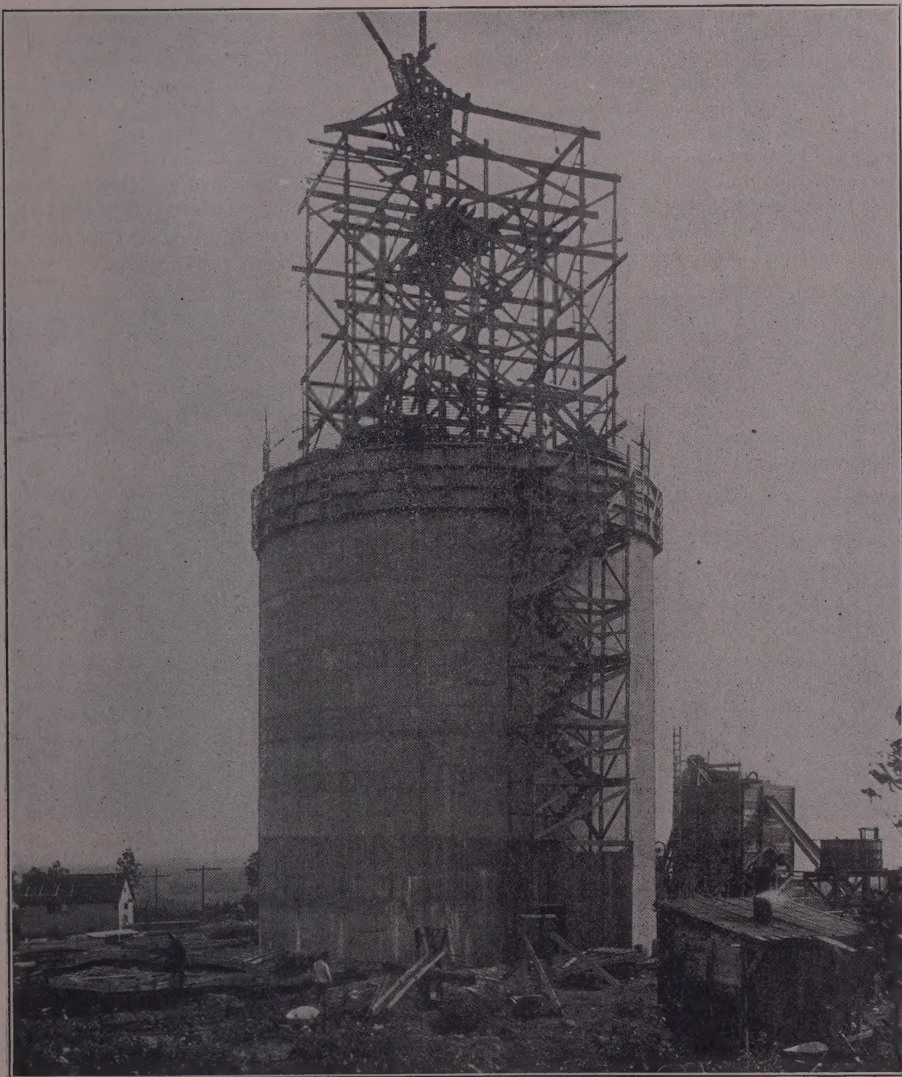
As already stated it was intended to use square twisted bars, but the impossibility of bending these in a plane necessitated the adoption of some other form, and round bars of 0.40 per cent. carbon steel, with an elastic limit of 50,000 lb. and an ultimate strength of 80,000 lb. per square inch, were finally adopted. It was also decided to use $1\frac{1}{2}$ -in. round bars, in two vertical rows at the bottom of the wall instead of the smaller steel bars in three rows, so as to facilitate the placing of the concrete. These two vertical rows were continued up to a height of 60 ft. above which a single row was used, while above 81 ft. in height the rods are $1\frac{1}{8}$ in. in diameter. The steel was delivered in lengths of $56\frac{1}{2}$ ft., three lengths with a lap of 30 in. at the ends, making a complete ring. The three rods in each ring were fastened together with Crosby guy rope clips.

The use of this 0.40 per cent. carbon steel and the consequent difficulty in bending and holding the bars to the proper circle constituted one of the principal difficulties in the construction work. This steel could not be bent in the work and it had to be passed through rolls which did not, in all cases, develop the true curve out to the extreme ends.

The placing of the steel was begun using the $\frac{5}{8}$ -in. twisted vertical bars as originally planned. It was soon ascertained that in order to maintain the horizontal reinforcement in proper alignment and with the desired vertical spacing, some other method of supporting these members would have to be adopted. The decision was made to use channels, 15 in the circle of the tank, with the webs placed radially and the flanges drilled at proper intervals for the reception of short lengths of $\frac{1}{2}$ -in. bars, on which the horizontal reinforcement was hung inside and outside of the channels. In this way the vertical and horizontal spacings of the horizontal reinforcement were insured.

With this method considerable difficulty was encountered in maintaining the $1\frac{1}{2}$ -in. rods in alignment, and the work would have been facilitated had additional channels been used. The use of the 0.40 per cent. carbon steel was responsible for this difficulty, Mr. Barbour said in his discussion, and had a softer steel been employed in the work the erection of the tank would have been rendered much more simple, and the final results more satisfactory.

Construction.—The regular routine in construction of walls was as follows: The erection of the steel for a height of about 7 ft., or the depth of the form used, the placing of the inside and outside form, the filling of the forms with concrete, then a cessation of the work to allow the concrete to set subsequent to the erection of additional steel. It will be noted that this schedule necessitated a considerable interval between the placing of the different layers of concrete. The feasibility of insisting on the continuous placing of the concrete was one of the debatable considerations in the early part of the work, and one contractor proposed to follow this scheme. Experience, however, early proved the impracticability of continuously placing the concrete in a tank of this size. In smaller structures where a complete outside form can economically be erected to the full height in advance of the work, and ribs for the inside form provided, so as to permit the rapid placing of lagging as the work progresses, then it may be possible, Mr. Barbour believes, to place the con-



Arrangement of Contractor's Plant.

the wall, thus providing a large number of spaces for the overflow of water in case of accident, this water hitting the back of the pendant, striking the belt course and then falling in a spray to the ground below, prevents any danger of accident by washing such as might occur if the overflow were limited to one place. The gate house contains two electrically operated gates, by which the standpipe may be cut out and direct service obtained from the pumping station to the town.

Atlas Portland cement was used in the concrete. The results of tests made from samples taken from one of each fifteen barrels are given in Table 1. These results show the cement to be especially fine ground.

The sand used was obtained locally and had on the average an effective size equal to 0.30 mm.

Immediately below the crusher three bins were placed, from which the material could be fed directly into a Smith concrete mixer. The material passing the finest screen was discharged into a sand bin, the medium-sized stone into the second bin, and the coarser stone into the third bin.

Mechanical analyses of the sand and aggregate were made daily and the material combined so as to reduce the voids to a minimum. Considerable information, too detailed for presentation here, was obtained in regard to the value of these mechanical analyses. In this connection it should be stated that while such analyses well justifies the expense, all the good results of a proper mixture can be readily discounted, in Mr. Barbour's opinion, during the placing of the concrete. Separation of the aggregate will, to some

crete continuously. In a tank such as this one the forms must be sectional and the steel must be supported by the concrete as it is erected. This means a cessation of the concrete between the moving and erection of the forms and steel, which cannot be avoided. By inserting bevelled tonguing pieces and by thoroughly washing the joint so as to remove all dirt and loose material, and by covering the joint with a layer of thin grout, before placing additional concrete, water-tight joints can be obtained, as was proved, since practically no leakage has occurred at any of the joints.

It cannot be too strongly emphasized, he says, that the final outcome in a structure of this kind depends upon the proper placing of the concrete and the maintenance of a uniform mixture up to the actual point of its being deposited in the wall. Success depends not only on an appreciation by the contractor of the necessary character of the work, but also by the workmen. With a mechanical mixer preparing concrete rapidly and a derrick raising it to the platforms from which it is shoveled into the forms, despite the fact that there were usually a tamper and spader to each shoveler, it was found that in certain places imperfect work would occur. These places were principally in evidence during the first few days of the work, and the quality of the concrete grew rapidly better with the acquired experience of the workmen. In several instances a mixture somewhat too wet was used with the result that the spading and ramming served to drive the stone to the bottom of the batch being placed, with the result that in these places porous spots occurred. It was clearly proven, Mr. Barbour thinks, that a mixture no more wet than would at all times support the aggregate was desirable. Placing concrete in a thin wall with a large part of the section occupied by two rungs of steel bars, calls attention to the possibility of the stone wedging in and around the bars in such a way as to prevent easy filling of the entire space. For this reason, he believes that round bars are better than square bars, because of the greater ease with which the concrete will fill underneath them. In this connection the advisability of using a thicker wall is also worthy of consideration. On the other hand, with a thicker wall certain sections of the concrete must be at a greater distance from the steel reinforcement and such sections, in case of deformation of the steel under tension, may lose the effect of the adhesion between the concrete and the steel with the consequent cracking of the surface.

In this connection the advisability of using a mortar or a mixture of sand and cement without stone, because of the greater ease and certainty with which it can be placed, may, Mr. Barbour thinks, also justify the resulting increased cost. It is estimated that in this standpipe if a mixture of 1:2 mortar had been used instead of the 1:2:4 concrete, the cost would have been increased \$2,300, with a 1:2½ mortar, \$1,500, and with a 1:3 mortar \$750. This extra expenditure in a structure costing \$35,000, may, perhaps, be justifiable, it is considered, in the decreased liability of imperfect concrete and the greater certainty of an absolute bond between the steel and the cement.

When the walls had reached a height of 20 ft., the tank was filled with water to the elevation of the bottom of the lower form. A considerable leakage at once developed. By plastering the wall, digging out the spots of obviously pervious concrete, the percolation was considerably decreased, but these spots of poor concrete have only recently always been more or less in evidence.

Immediately on the completion of the foundation of the standpipe a hard pine tower was constructed on the interior of the latter to an elevation of 60 ft. On this tower a derrick was

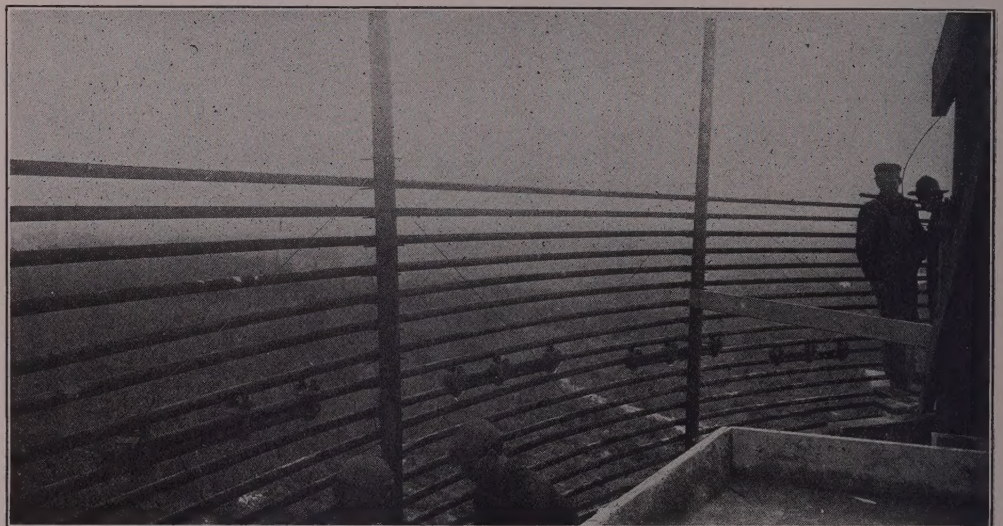
erected and maintained at this elevation until the wall reached the top of the tower. The tower was then carried up to an elevation of about 110 ft., and the derrick again raised. This tower was entirely independent of the walls and served merely to support the derrick and dumping platforms from which the concrete was shoveled into the forms. The existence of this independent structure, Mr. Barbour said, was unquestionably of advantage in handling the materials, both the concrete and steel. The tower, including the raising of the derrick, cost about \$1,700.

Outside forms made in sixteen sections about 7 ft. high, with horizontal ribs and vertical lagging and locked together by clamps on the ribs, were provided in two sets one above the other, the lower one being loosened and placed above the first as the wall progressed upward. These forms were held in place solely by the binding effect of the clamps and the consequent friction on the completed wall. The interior forms were constructed of ribs on which horizontal straight lagging was laid during the progress of placing the concrete, in order to give the concrete spaders a better opportunity to work between the steel. The forms were not as heavy as Mr. Barbour believes is desirable and should have been provided with more diagonal bracing and better means of

it would frequently be found that the forms had moved during the placing of the concrete a fraction of an inch.

The Crosby clips used in tying the ends of the three rods in each ring together were placed three at each joint. Aside from the increased bond thereby assured, they were necessary with the steel used in order to tie the ends together and hold them in place during the filling of the forms with concrete. Without these clips Mr. Barbour is of the opinion the wall never could have been erected. Joints put together in this manner on the work, and tested at the Watertown Arsenal proved that the three clips developed the working stress of the steel. As the clips failed by tipping, it is believed that, allowing for the supporting effect of the concrete, the joints in the work will develop the elastic limit of the steel.

The cost per cubic yard of the 1:2:4 concrete in the walls was approximately as follows: Cement, \$4.80; sand and stone, \$3.90; mixing concrete, \$0.40; placing concrete, \$2.20; form work, \$2.65; total, \$13.65 per cubic yard. Bending and placing steel cost about \$9 per ton, or \$2.30 per cubic yard of concrete. There were 770 cu. yd. of concrete in the walls and about 185 tons of steel. The clips, of which about 3,000 were used, cost \$1,100.



Steel Reinforcement in Place Showing Clips at Joints.

connection and clamping at the ends. The batter which was given the outside of tank increased the difficulty in handling the outside forms which has to be adjusted from time to time to the varying circumference. Mr. Barbour questions whether the added architectural effect given by this batter justified the increased difficulty in handling the forms. He also states that it would have paid to cover the outside forms with sheet metal.

One of the conditions to be strenuously avoided in the construction of a concrete structure similar to this one, he says, is the possibility of either the steel or the concrete moving after the concrete has been placed and partially set, so as to follow the movement of either the steel or form. With the high carbon steel used in this work and the difficulty of maintaining it in place without the rings being under some stress during the filling of the forms with concrete, it seemed impossible to avoid the chance that some movement of this steel might take place which would result in the formation of a void in the concrete wall. This was also true of the sectional forms. Despite the fact that with each moving of the lower set of forms upward on the wall the circle was carefully measured by a steel tape from a centre wire on a heavy plumb bob from an independent tower in the centre of the tank,

The work of placing the concrete in the walls, because of various reasons, progressed slowly, and the cornice was not completed until after October 1. After this the tile roof was constructed with the consequence that plastering the interior surface was not begun until cold weather had commenced. An attempt was made to heat the interior so as to permit the completion of the plastering, but this was found to be impracticable. By agreement with the contractor the town concluded to use the structure throughout the winter, despite the fact that from the beginning of construction more or less leakage had been in evidence. On the entire surface, however, only three jets occurred, these spurting out near the bottom, and at no time has there been a wetting through of more than 2 per cent. of the entire surface. The principal reason for concluding to keep the structure full of water was the hope that with use the leakage would decrease by precipitation of the carbonates in the voids of the concrete. This action has always been in evidence, and frequently leaks will absolutely stop and then apparently, by the breaking of this carbonate dam, subsequently open. It is to be noted that at no time, so far as the amount of water loss is concerned, have the leaks been serious, and if the standpipe were located where freezing weather did not occur, the struc-

ture would have been satisfactory even in the condition under which it was used last winter.

The use of the standpipe developed, in certain places along toward spring, spots of several square feet in area which scaled off the exterior surface, apparently being thrown out by pockets of water which had collected, frozen and expanded. These pockets were unquestionably due to the movement of the steel or forms during construction at a time sufficiently after the placing of the concrete that some set had occurred. This scaling of the exterior surface was confined to areas in the bottom 15 to 18 ft. of the tank. No additional leakage developed and in all cases the concrete tank, other than these scaled areas, remained in excellent condition.

With the return of spring the completion of the work was undertaken, including the repairing of the defacement of the outer surface and plastering the inside. The result has been that with the completion of the plastering, the leakage was decreased to practically a sweating in a limited number of spots. Since then a number of alternate coats of castile soap and alum have been applied with the consequence that recently there have been no signs of any leakage except in one spot about a foot square where there was a slight sweating.

Prior to applying the first coat of plaster on the inside of the standpipe, the entire surface was thoroughly cleaned and then picked to insure a bond between the plaster and the concrete surface. Four coats of plaster were applied. The first coat contained 2 per cent. of lime to 1 part of cement and 1 part of sand; the remaining three coats were composed of 1 part sand to 1 part cement. Each coat was floated until a hard, dense surface was produced, then this surface was scratched to receive the successive coats. On filling the standpipe after the four coats of plaster were applied, Mr. Snell said the desired results were not secured as the standpipe was not absolutely water-tight. The water was finally drawn out and four coats of a solution of castile soap and one of alum were applied alternately. This latter work had been completed to a height of only 35 ft. when Mr. Snell's paper was prepared and under 100 ft. of head only four leaks had appeared where the solutions had been applied.

The working stress in the steel varies from 8,000 to 13,500 lb. per square inch. At the highest limit the maximum deformation in the steel, due to water pressure, will be about 0.43 of an inch in the semi-circumference. The adhesion between the steel and the concrete, which Mr. Barbour considers many times in excess of the working tensile stress, prevents movement of the concrete on the steel, but at the surface section most distant from the reinforcement minute cracks have developed, invisible when the wall is dry, and only to be found as the tank is drying out. This suggests to Mr. Barbour the advisability, perhaps, of distributing the reinforcement so as to bring it as near the inside surface of the tank as possible in such a way that the interior section will partake of the adhesion between steel and concrete. On the other hand there are some reasons for concentrating the steel as nearly as possible in one plane in order to make certain that all rods are brought under tension uniformly.

As all steel structures economically designed Mr. Barbour thinks must be based on some deformation, and as in this case the elastic reinforcement is surrounded by a particularly inelastic medium, it would appear that except so far as the adhesion of the steel and the concrete will counteract the results of stretch in the structure, water-tightness must be obtained by some elastic coating which will cover the minute checking of the surface. It is, of course, unnecessary

to state that these cracks are absolutely microscopic and entirely invisible except as indicated by the narrow wet streak which remains after the tank has practically dried out. It has been suggested that by adding lime or soap to the concrete, the concrete might be made more waterproof. It is questionable to Mr. Barbour whether this would prevent the checking of the surface, and unless it is possible to use steel with such stress as to bring the structure within the elastic limits of the concrete, waterproofing under higher heads must be obtained by an elastic skin coat. This coat the Sylvester process is apparently able to provide.

Because particular attention was paid in Mr. Snell's paper and in the discussions of it by Mr. Wason and Mr. Barbour, to the difficulties encountered and to the possible improvements in future design the latter says that the conclusion should not be drawn that the structure is not a success. The engineer, contractor and the authorities at Attleboro have always been perfectly satisfied with this type of reservoir.

Summing up the results of experience, Mr. Barbour says it would appear that a soft steel should be used, distributed so as to permit as much greater section of the steel to partake of the effects of adhesion as possible; that extreme care must be taken to prevent movement of the forms and steel during the placing of the concrete, and that in all probability the greater ease and surety of absolutely filling the voids will justify the use of a mixture of cement and sand alone or, perhaps, with fine, clean, screened gravel added, the primary endeavor to be to make the body as a whole as homogeneous and impervious as possible, trusting final waterproofing to a fine coating of some elastic preparation, the necessary attributes of which were apparently fulfilled by the so-called Sylvester process.

REPAVING BETWEEN STREET RAILWAY TRACKS has been decided to be obligatory upon traction companies in a case recently passed on by the Supreme Court of Pennsylvania, 64 Atl. Rep. 446. The city of Reading ordered asphalt pavement to be laid on a number of streets and notified the United Traction Co. to lay similar pavements along its tracks. This was not done by the company, so the city executed the work and sued for its cost, securing a favorable verdict in the trial court and recently in the supreme court. The company's contention was that it was not required by its franchise to keep the street surface in repair and hence it could not be legally charged with the expense of the pavement. The essential point of the Supreme Court's decision is as follows: "When the State gives up a portion of one of its highways to a particular use, without providing that what has been the duty of the municipality as to it shall continue, such duty devolves upon the party acquiring the right to use it, and a street railway company, given the right to use such portion of a street as is needed for its tracks, in taking charge of it is charged with the duty of properly maintaining it. It is because the municipality, as the agent of the State, has charge of the streets, that it must maintain and keep them in proper repair, and when the State permits this charge, as to a portion of a street, to be committed to another, it must be understood as imposing upon such party the responsibility that formerly rested upon the municipality, unless in the grant, or the municipal consent thereto, of the right to use a portion of the street, such responsibility is expressly withheld and its imposition continued upon the municipality." Doubt inevitably arises as to a city's ability to compel traction companies to pay for such paving, even when ordered by legislatures, city councils and courts. It has proved very difficult in other cities than Reading.

Grade Rectification in the Battery Tunnel, New York.

Work on about 2,500 ft. of grade rectification in the east approach of the East River tunnel of the New York Rapid Transit Ry. was commenced April 1, as described in The Engineering Record of June 2. The tunnel at this point has a concrete lined segmental cast-iron shell with a clear inside radius of 7 ft. 8¾ in. with segments 22 in. long. The two parallel tubes were driven by heavy hydraulic shields, which, in passing through sand at ground-water level, deviated from the required alignment causing irregularities, which, together with some distortion of the lining encroached so much on the necessary headway that in some places there was no clearance for train service at the proper grade. It was decided to modify the original grade slightly so as to eliminate sudden irregularities by elevating the track in some places and depressing it in others. In the latter case the change is being made by removing the original invert and rebuilding it at a somewhat lower level, thus changing the cross-section of the tunnel.

The imperfect portions of the tunnel were divided into several sections on a number of which work has been simultaneously progressing. The first sections were executed by a method already described which consists of the removal of small portions of the cast-iron invert at frequent intervals, building there new horizontal concrete inverts at a lower level, supporting on them falsework bents which carry two continuous lines of horizontal steel girders at about the springing line of the tunnel. On these girders a second story of falsework bents, 4 ft. 8 in. apart on centers, is set, which with radial side braces secure a continuous length of the tunnel lining, transfer its weight and that of the earth roof to the new sections of invert and allow the intermediate sections of old invert to be replaced by concrete invert and concrete side walls carried up nearly to the springing line where they join the old segments with special skewback blocks. The concrete work is built in sheeted excavation and is carefully waterproofed with sheet lead calked with the old segments.

These operations give a horseshoe shape section and have been successfully conducted under atmospheric pressure up to a point where the ground water level is about 5 ft. above the invert. Here the tunnel is drained by four 4-in. well points driven into the sand bottom where the cast-iron invert segments are removed and connected to three double-action hand pumps. A force of about 50 men in the south tube have replaced 90 rings of invert with the concrete construction and have nearly reached the limits which it is believed are desirable for the execution of this work under atmospheric pressure. Work was commenced in the east end of the defective section of the north tube at about ground-water level, June 15. About 20 rings of cast-iron invert have been replaced by concrete and the timbering is well advanced for about 50 rings more, which it is expected to replace by this method.

As the ground-water level in the defective portions of the south tunnel reaches a maximum of about 13 ft. above the present invert, it is not thought wise to attempt reconstruction under atmospheric pressure in the deepest parts and operations have been commenced under pneumatic pressure in a section 200 ft. long back of the bulkhead on the Brooklyn side. Here two brick bulkheads 3 ft. thick were constructed and in each of them was built a 6-ft. air lock 12 ft. long, dimensions sufficient to admit a carload of materials. A pressure of 8 lb. per square inch, slightly above the hydraulic pressure, has been

maintained and under it reconstruction of the invert has been commenced that is different from the concrete work adopted under atmospheric pressure. Here it was decided to replace the original invert segments with similar new cast-iron segments proportioned to elongate the vertical axis of the tunnel section by a maximum increment of about 20 in. The line of the roof and side walls remains unchanged down to the first joint below the springing line, beyond this point, the old segments are removed and the lengths and curvatures of the new ones are modified so as to transform the old circular cross-section to an egg-shaped cross-section, narrow at the base and resembling an ordinary egg-shaped sewer section. This involves the replacement of four or five duplicate original segments of each ring by five or six special new segments, one of which near the center line of the invert is very narrow, like the key piece usually put in the crown of the ring.

Transverse wooden sills are fitted to the in-

another ring is removed, the operation repeated and so on until the lower bent of falsework is reached. As fast as the replacement progresses grout is forced through the new segments by a Douglas pump, and when the lining has been replaced between the two falsework bents one of the latter is removed and set up on the new invert before reconstruction is extended over its former position. So far the work has been satisfactorily accomplished with little difficulty and with only a small loss of air through the bottom when the lining was removed. This calking of the segments, although going on with the reconstruction work, is independent of it, and is in progress in other parts of the tunnel as well.

Originally the segments of the cast-iron lining were assembled with grummets made of candle wicking saturated in oil, under the heads and nuts of the flange bolts. These were not found effective and hemp grummets, thoroughly covered with a mixture of white lead, red lead, and Japan dryer made into a thick paste, are now

tender. The corresponding timbering is done in one shift by a gang of six men. It is expected that a speed of five rings in two shifts will be attained before the completion of the work.

Work is being done under the direction of Mr. George S. Rice, chief engineer; Mr. Frederick Noble, division engineer for the New York Rapid Transit Commission. It is executed for the Rapid Transit Subway Construction Co., Mr. George H. Pegram, chief engineer, by Cranford & McNamee, Mr. J. C. Meem and Mr. W. I. Aims, engineers for this portion of the work.

The Bactericidal Action of Copper.

The bactericidal action of copper in water purification has been studied at the Lawrence Experiment Station of the Massachusetts by Messrs. H. W. Clark and S. De M. Gage, who conclude that the treatment of water with copper sulphate or by storing it in copper vessels has little practical value, for the following reasons: I, The



Excavation for New Segments of Lining.



Footings for Falsework in Tunnel.

vert 14 ft. apart and on each of them are set, 4 ft. apart, two 5-ft. vertical posts with horizontal caps which receive a pair of longitudinal girders 5 ft. apart. Each girder is made with a pair of 15-in. channels bolted together back to back with a 20-in. I-beam between them, the different members breaking joints so as to provide a continuous girder distributing its load over a number of vertical bents. Transverse sills 14 ft. 8 in. apart are placed on the girders and support second story vertical bents of falsework with cap pieces fitted to the lining segments and wedged against them. Radial braces are also fitted to the longitudinal girders and falsework.

At convenient points between the lower vertical bents the invert segments of two adjacent rings are removed up to the first joints below the springing line. The sand underneath them is found dense and comparatively dry without voids. No tendency to displacement is observed and the surface is very carefully scraped and trimmed by hand, until an excavation is made permitting the new invert segments to be assembled in it with slight clearance. They are flange bolted together in the usual manner and the upper flanges being secured to the lower flanges of the old segments become suspended from them. The sand is then carefully tamped under the new segments,

used. The grummet is moulded into a ring which is placed around the bolt and covered with a steel washer on which the bolt is drawn tight. The joints between the segment flanges are cast with a calking groove. Difficulty is experienced in filling this groove with the salammioniac and iron filings necessary for a rust joint and as it is also impossible to make this joint when the surfaces are wet, it has been replaced by a lead joint made with a lead cylinder $\frac{3}{8}$ in. in diameter which is calked with a blunt nose tool and is retained by the rough sides of the recess. This joint and the new grummets made the shell thoroughly water-tight so that when the reconstruction was temporarily suspended, the speed of the air compressor dropped from 50 to 13 r.p.m., while maintaining a uniform pressure of 8 lb. in the tunnel.

The total amount of lining to be reconstructed is about 2,500 lin. ft. of which 200 ft. has already been done and 100 ft. more will be done with the concrete invert made in atmospheric pressure. Of the remaining 2,200 ft., about 80 ft. has been completed and the remainder will be done under pneumatic pressure as above described. The new cast-iron invert is now being placed at the rate of about three rings in two 10-hr. shifts by a force of eight men and lock

use of any method of sterilization which is not absolutely effective is dangerous in the hands of the general user, tending to induce a feeling of false security, and leading to the neglect of ordinary precautions which would otherwise be employed. II, The removal of bacteria, *B. coli* and *B. typhosus*, by allowing water to stand in copper vessels for short periods, while occasionally effective, is not sure, and the time necessary to accomplish complete sterilization is so long that the method would be of no practical value to the ordinary user. Furthermore, metallic copper seems to have little more germicidal power than iron, tin, zinc, or aluminum. III, Although the removal of *B. coli* and *B. typhosus* is occasionally accomplished by dilute solutions of copper sulphate, these organisms may both live for many weeks in water containing copper sulphate in greater dilutions than 1:100,000; and in order to be safe dilutions of 1:1,000 must be used, in which case the water acquires a strongly astringent taste. IV, In some instances very dilute solutions of copper sulphate or colloidal copper absorbed from contact with clean metallic copper, appear to have a decidedly invigorating effect on bacterial activity, causing rapid multiplication, when the reverse would have resulted had the water stood the same time without any treatment.

The Power Plant of the Pittsburg Terminal Warehouse and Transfer Co.

An extensive terminal warehouse and freight transfer building has recently been erected in Pittsburg, Pa., by the Pittsburg Terminal Warehouse & Transfer Co., for general shipping and freight transfer purposes, a special feature of which is the provision of numerous independent private storage warerooms for individual firms, which may thus receive, store and ship their merchandise at the one building, and avoid the trouble, expense and delay involved in carting freight in the usual manner from railway stations to city warehouses and back again for re-shipment. The project is an extensive one, embracing a six-story and basement main storage warehouse containing over 250 separate storage rooms, occupying a total floor area of nearly 1,100,000 sq. ft. Freight is handled to and from the upper floors by 44 electric elevators, for the operation of which, considerable power is required. A large cold storage warehouse is also involved. The scheme of the enterprise includes the eventual addition of grain elevators and also a river transfer station for the handling of freight to and from steamers on the Monongahela River adjoining.

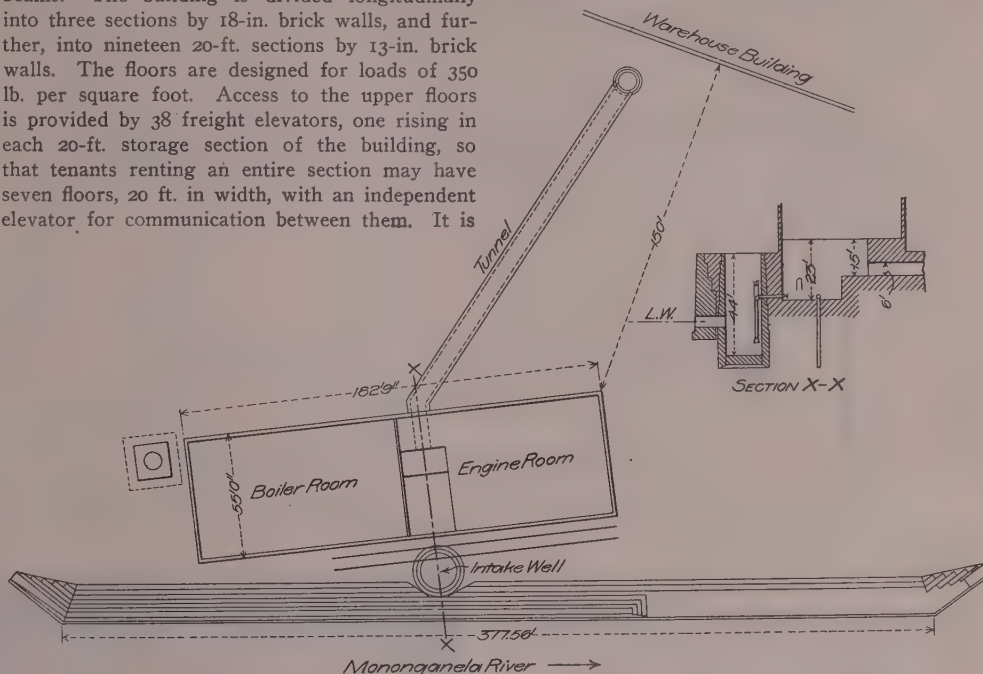
The warehouse building, which occupies a ground plan of 380 x 455 ft., is located on the south side of the Monongahela River, in Pittsburg, covering the entire block bounded by McKean St. on the front, the tracks of the Pittsburg & Lake Erie R. R. at the rear, and Third and Fourth Sts. at the sides. It is a steel-frame fireproof structure, 90 ft. in height and contains a basement and six stories, the first floor of which is on a level slightly above that of the

of the warehouse building, being separated from it by over 150 ft., but is still convenient for piping and wiring connections and also for water supply from the river. The entire warehouse and terminal plant together with the office building, covers a space of three city blocks and has a frontage on the river of 382 ft.

The warehouse building is of fireproof construction, involving a design of hollow-tiled floor construction, forming vaulted arches between the beams. The building is divided longitudinally into three sections by 18-in. brick walls, and further, into nineteen 20-ft. sections by 13-in. brick walls. The floors are designed for loads of 350 lb. per square foot. Access to the upper floors is provided by 38 freight elevators, one rising in each 20-ft. storage section of the building, so that tenants renting an entire section may have seven floors, 20 ft. in width, with an independent elevator for communication between them. It is

shipment, for which six platform elevators are installed to handle it to the platform below.

The power house is a two-story structure, 55 x 182 ft. in plan, of steel-frame construction, with brick curtain walls and is divided into a 93-ft. boiler-room and an 89-ft. engine-room. It is located in the 100-ft. space between the river and the railroad tracks, the tracks separating it from the warehouse building. Along the river front, a retaining wall, 377 ft. in length has been built



Plan of Power House and Tunnel Connection to Warehouse Buildings.



View of the Power House from the Warehouse Buildings.

adjoining railway tracks, while McKean St. passes the building at an elevation some 30 ft. above. At the latter level the upper portion of the warehouse building is divided and a bridge 34 ft. in width carried through transversely and across the railway tracks to the river bank where the power plant for the operation of the building service is located, and where also will be eventually located the river transfer station. The power plant is thus entirely independent

the purpose, however, to rent any number of floors or sections, as may be desired, openings being provided between adjacent sections for communication between, where desired. Freight is handled to and from the warehouse on six tracks entering on the first floor level and passing transversely through between loading platforms. The space on the second floor, beneath the bridge passing transversely through the building, is utilized for packing freight for re-

to a height of 30 ft. above low water level, in which is incorporated a water intake well for the river water supply. The boiler-room portion of the building is a single story in height, with a clear head room of 40 ft. under roof trusses, while the engine-room section consists of an upper story with 9 ft. of head room and a lower story 28 ft. under floorbeams, giving sufficient space for a traveling crane over the electrical generating units with 21½ ft. of free head room beneath. The building is without monitor construction, windows at an upper level in the boiler-room providing sufficient ventilation. The roof is of tongue and groove wooden construction carried on 9-in. channel purlins spaced 5 ft. apart, and is covered by Warren Ehret four-ply roofing. The floor of the power house is located at a level 2 ft. above the highest stage which the Monongahela River has ever reached under flood conditions. In one corner of the engine-room, however, there is a pump pit, 20 x 37½ ft. in plan, depressed 26 ft. for the accommodation of the fire pumps. From one side of this pit an arched pipe tunnel, 6 ft. wide by 6 ft. high and 185 ft. long, extends to the warehouse building. In this tunnel the pipe connections for the water, sprinkler and heating service in the warehouse and office buildings are carried.

A boiler plant of 1,500 h.-p. total capacity, consisting of six 250-h.-p. Babcock & Wilcox watertube boilers, arranged in three batteries of two boilers each, has been installed. The boilers embody the usual Babcock & Wilcox sectional wrought-steel header construction, each having a total heating surface of 2,500 sq. ft., and are designed to operate at 160 lb. pressure. Their furnaces are fitted with Roney mechanical stokers, to which coal is fed directly from storage bunkers overhead by swiveling down spouts, having spreaders at the bottom in order to distribute the coal over the full width of the stoker grates. The furnaces are operated with natural draft, the settings connecting through a fire-

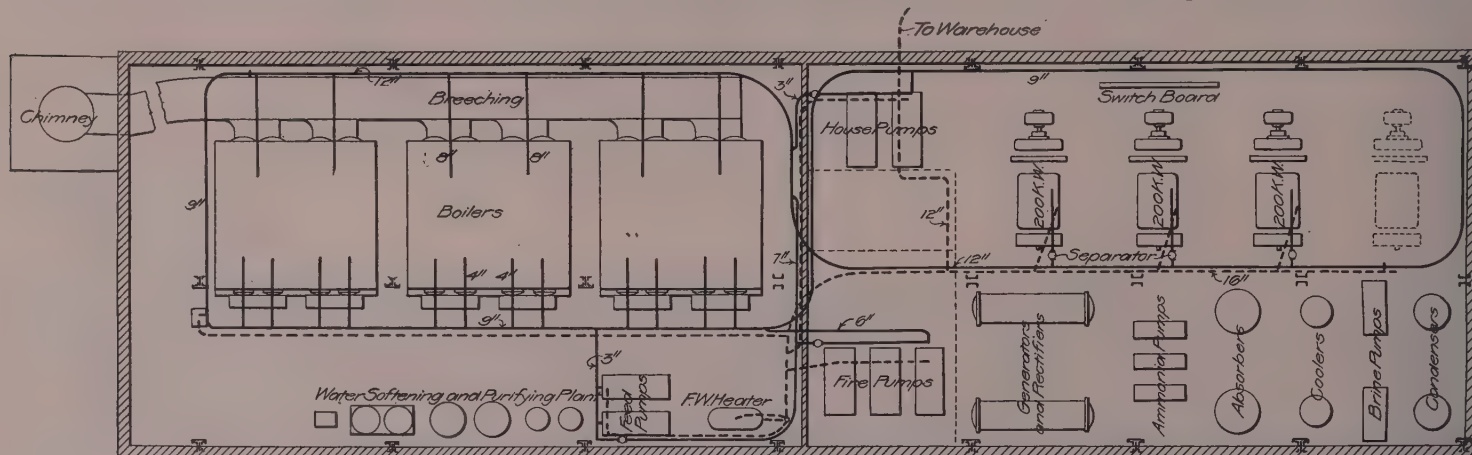
brick breeching carried on a structural-steel platform at the rear of the boilers, to a 145-ft. brick stack at the adjacent rear corner of the building. This stack is of the perforated radial brick construction with an inside diameter at the top of 7½ ft.

Provisions are made for handling both coal and ashes mechanically throughout, coal being received in a track hopper beneath a side track along one side of the power plant building, to which it is dumped directly from the hopper bottom railway coal cars. It is conveyed from this hopper to a coal crusher in the power plant

ion wall, and contains three Underwriters' fire pumps, each of 1,000 gal. capacity. Two of these were put in for the automatic sprinkler system and one for general water pumping service, delivering to two general storage tanks. These pumps are flexibly connected on both suction and delivery sides so that any one of the three can be used for either purpose. They have 8-in. suction connections carried down to within 5 ft. of the bottom of the well. There is also room provided in this pit for two additional pumps to lift water from artesian wells which now discharge water at an average temperature of 54°

sired. From the tanks a 3½-in. feed header is carried the length of the boiler-room above the boilers. There is also a 2-in. auxiliary feed header paralleling the 3½-in. header, which is supplied directly from the pumps for emergency service. The boiler connections are all 2 in., joining into a common check and stop valve.

The water from the Monongahela River always contains considerable quantities of scale-forming substances, together with sulphuric acid often combined with iron as iron sulphate, and in addition considerable amounts of suspended matter. In order to protect the boilers from corro-

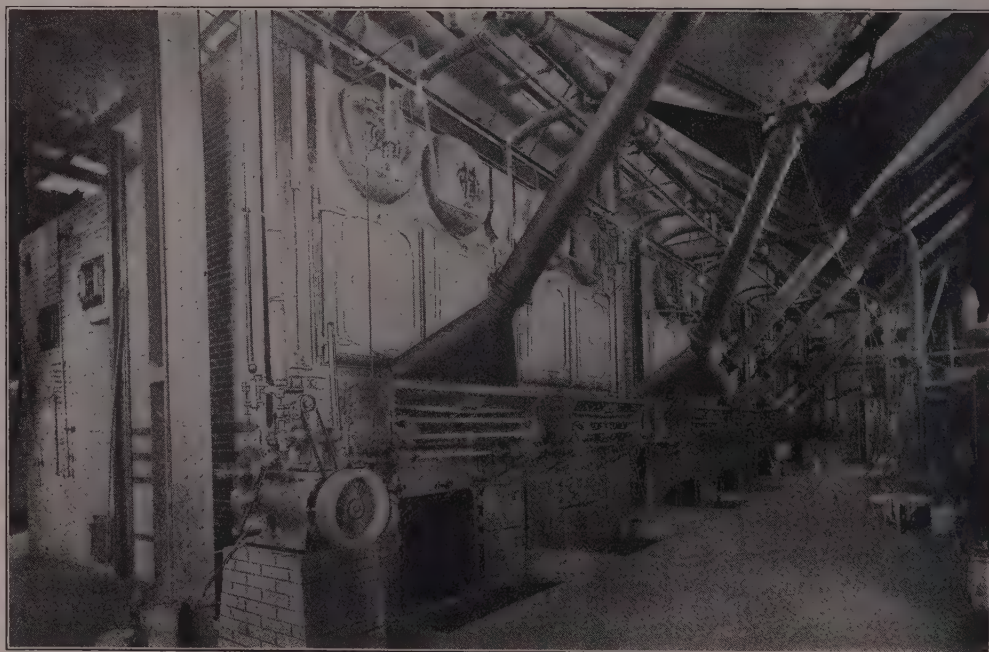


Plan of the Power Plant Showing Steam Piping System.

basement and elevated thence by a continuous bucket conveyor to the storage bunkers above the firing floor of the boiler-room. Six of these elevated bunkers are installed, one for each boiler, each bunker having a capacity of 80 tons of coal, or 480 tons for the entire plant. These bunkers are of steel-plate construction, carried on the steel framing of the power house, and intermediate posts between the boiler settings. They are of pyramidal form, built of 5/16-in. steel plates, strongly reinforced, each having an outlet gate at the base below which is attached the swiveling delivery spout. The latter is of 12-in. pipe and has a ball-bearing socket support at the base of the hopper. The same conveyor system is employed to handle ashes, the system passing, on its lower horizontal run, through the boiler-room basement in front of the outlet doors of the furnace ash pits, so that the ashes may be scraped directly into the conveyor.

The water supply for the plant is taken from the Monongahela River, adjacent, and owing to the constant turbidity of the water, all water for boiler feed is passed through a softening and purifying plant. The house and fire pumps have their suction in the intake well built into the retaining wall next to the river; as above referred to. This intake well, which is of reinforced concrete construction of circular cross-section, is 16 ft. in diameter and was carried down to a depth of 44 ft., the bottom being 14 ft. below the lowest stage of the river on record. It is connected to the river by a 5-ft. opening through the retaining wall, the center of which is on a level with the low-water stage, so that it serves effectively as a settling chamber. The 5-ft. intake is provided with a sluice gate which shuts the river off from well for cleaning purposes, and there are two sets of wire screens fitted across it to prevent access of rubbish.

On account of the great differences between the low-water level and the flood stages of the Monongahela River, amounting occasionally to as much as 34 ft., it was found necessary to locate the pumps in a pit 26 ft. below the main floor level of the power plant, in order to bring them down to within a reasonable suction height during low water. This pump pit is located in the engine-room at one corner next to the divis-



General View in the Boiler Room.

Fahr. This water is used as cooling water for the ammonia condensers of the refrigerating machinery equipment.

Water is delivered from the general service pump into two cylindrical steel tanks, 18 ft. in diameter by 10 ft. high, which are located on the second floor above the engine-room, and from these the water supply for the power plant and warehouse is taken. For the boiler-feed system it passes first through the open feed water heater and is delivered from there through the water softening and purifying equipment, to the boilers. The feed pumps consist of two 10x6x15-in. duplex steam pumps of the outside center-packed plunger type. The feed water heater is of the open type and has a capacity of 2,000 h.-p. It is located in the boiler-room, and receives its steam for heating the water from the exhaust steam system of the plant. The feed pumps deliver through 4-in. connections to the purifying tanks, with a by-pass to cut out the latter if de-

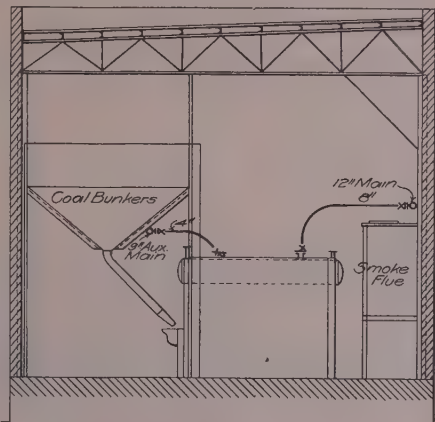
sion and to prevent the formation of scale, a water softening and purifying system, manufactured by Wm. B. Scaife & Sons Co., of Pittsburgh, Pa., was installed. The feed water is taken after leaving the open heater at a temperature of about 200° Fahr., from which the feed pump forces it through the purifying system. This purifying system consists essentially of two precipitating tanks, two filters, two chemical solution tanks and a pump for introducing the chemical solutions. The operation is as follows: The water enters the first precipitating tank where the first reaction takes place and then into the second precipitating tank where the second reaction takes place. Most of the precipitates, together with the suspended matter, is blown out through the blow-off valve provided on these precipitating tanks. The finer suspended matter, that which will not settle out, is carried to the filters and there removed, the water going to the boilers soft and clear and

entirely free from scale-forming and corroding substances. The chemicals are introduced by means of a special triplex pump direct connected to a motor which is operated in direct proportion to the rate at which the water is used. The chemicals are stored in the solution tanks which are charged about every 12 hr. The filters are of the regular pressure type, built especially for the purpose intended, and are washed by reversing the flow of water through them. By means of this system it has been found that the boilers are kept perfectly clean and that it absolutely prevents the corrosion usually resulting from using Monongahela River water without purification.

Steam is supplied from the boiler-room to the engines and pumps by an arrangement of ring header which encircles both the engine and boiler-rooms, the connecting lines crossing at the division wall in the form of a figure eight. The boilers each have two delivery outlets, a main 8-in. delivery nozzle at the rear, and the other involving the two 4-in. safety-valve connections upon the forward ends of the steam drums. The 8-in. nozzles connect to the main 12-in. header at the rear of the boiler-room, while the two safety valve nozzles at the forward end of the boilers each have 4-in. connections into an auxiliary 9-in. header. These main and auxiliary headers are cross connected at the rear of the boiler-room by an extension of the auxiliary header thus forming the ring main, while at the division wall section of the plant the two head-

broken into numerous short sections by stop valves and are liberally provided with separators which are drained together with the pocket points in the mains by steam traps, to the open feed water heater. All steam mains, together with separators and valves, are insulated with a plastic asbestos covering.

The generating equipment embraces three direct-current generating units, consisting of 200-kw. Westinghouse engine type generators direct connected to 300-h.-p. Westinghouse compound engines of the standard vertical single acting type. The engines operate at 250 r.p.m., and are governed by the standard form of cen-



Cross Section Through Boiler Room.



Electrical Generating Units and Piping Connections in the Engine Room.

ers are cross connected in two places, by a 2-in. and a 7-in. steam line, both of which serve as steam supply mains to auxiliary equipment. The 2-in. line delivers steam to two house pumps of 250 gal. capacity per minute each, while the 7-in. line provides for the operation of the three fire pumps and the two boiler feed pumps. The 7-in. line branches into a 6-in. connection to the pump pit for the fire pumps, which branch has a 6-in. supplementary connection to the auxiliary header, while a 3-in. branch is continued to supply the boiler feed pumps, which also has a 3-in. supplementary connection to the auxiliary header. The main and auxiliary headers are continued into the engine-room, the main header being fitted with 8-in. branches to each of the three generating units and having provision for a fourth branch to supply a projected future unit; beyond this point the header reduces, connecting with the 9-in. auxiliary header which is carried around to it from the opposite side of the engine-room. The various headers and mains are

trifugal inertia governor. The units are mounted on raised foundations to avoid pits in the floor for the flywheels and are accordingly fitted with elevated working platforms, at a height of 6 ft. above the floor, to facilitate access to the cylinders and throttles. The generators are eight-pole, slow-speed machines, delivering at 250 volts on the two-wire system and are designed for overload capacities of 25 per cent. continuously. The generators and electrical distribution circuits are controlled from an eight-panel switchboard, on the generator side of the engine-room, consisting of 3 generator panels and 5 feeder panels. The panels are of blue Vermont marble, 24 in. in width, and are provided with the usual indicating and recording instruments and circuits. Two bus-bars are provided so that the power and lighting circuits may be fed and controlled from separate busses, and integrating wattmeters, permanently connected into each bus, record the current used for both lighting and power.

The electric lighting and power equipment for the warehouses is operated on the two-wire system, 220 volts at the outlets, with two wire feeders to both lights and power. The lighting system for the entire building is controlled by six main panel boards located on the second floor, to which lead the six main feeder circuits coming from the switchboard in the power plant. There are twelve sub-panel boards on the station floor controlling the station floor lamps. These panel boards and sub-panel boards are enclosed in iron boxes with black enameled slate, and the branch circuits have 10 ampere enclosed fuses without knife switches.

The station floor is lighted by 40 Cooper-Hewitt lamps, of 300 vertical candle-power. The balance of the building is lighted by approximately 4,000 incandescent lamps of 16 c.-p., installed on 400 sub-circuits with control by flush push switches. There are eight main feeder circuits for the elevators and one feeder circuit for machinery motors, which are controlled from the main panel board in the power plant. The main feeder circuits for the lighting and power system are run in enameled steel conduits from the main switchboard in the engine-room, across and over the railroad tracks supported by the bridge connecting the warehouses with the power plant. The sub-feeder circuits are also run in enameled steel conduits, partly concealed and partly open work.

The brine required for the cold storage plant is cooled in two refrigerating machines of the ammonia absorption type, which can be operated with exhaust or live steam as found expedient. Each of the refrigerating machines has a cooling capacity equal to that of 75 tons of melting ice per twenty-four hours, and is capable of cooling 375 gal. of calcium chloride brine of 1.225 specific gravity and of 0.7 specific heat through a range of 5° Fahr. per minute, with the outlet brine at 5° below zero Fahr. There are two 14x12x18-in. pumps of the direct-acting duplex piston type, for circulating the brine.

The cold storage department of the warehouses consists of fourteen rooms with a total storage capacity of about 604,200 cu. ft. The rooms are insulated and protected against the egress of cold and the ingress of heat in a most efficient manner by means of two layers of nonpareil cork boards, 2 in. thick, which are finished on the inside of the room with cement plaster. The cold storage room located on the fourth floor can be cooled down to a minimum temperature of 5° Fahr. below zero, and the rooms on the fifth and sixth floors can be cooled down to a minimum temperature of 20° Fahr. above zero. The cooling in these rooms is produced by a system of pipe lines through which circulates the cooled brine coming from the refrigerating plant in the power house. The main brine lines between the brine pumps and the headers in the storageroom are run in the tunnel under the railroad tracks connecting the warehouse with the power plant. The brine circulating system for these rooms contains about 40,000 ft. of 2-in. pipe, 2,500 ft. of 8-in. pipe, 800 ft. of 4-in. pipe, and 400 ft. of 6-in. pipe.

The goods are handled by means of 38 direct electric freight elevators, one in each warehouse, and six short rise direct electric freight elevators located in the center of the building on the main platform. Each of the thirty-eight elevators has a lifting capacity of 4,000 lb. at a speed of 100 ft. per minute with the maximum load. Each of the six short rise elevators has a lifting capacity of 6,000 lb. with a speed of 60 ft. per minute with the maximum load. The elevators are equipped with full magnetic control and the most improved safety devices. The elevators are also provided with an electric annunciator and semi-automatic safety gates at all landings. The

cages are of steel construction with wooden platforms.

The offices of the warehouses are heated by direct radiation with exhaust steam from the power plant, which is brought over to the warehouses in a 12-in. pipe running through the tunnel under the railroad tracks. The heating system installed is a one-pipe gravity-return system. The returns from the radiators are trapped into a catch basin by means of low pressure traps and the catch basins discharge the condensed water into the sewer.

For fire protection the warehouses are equipped with an automatic sprinkler and fire extinguishing apparatus of the Grinnell dry-pipe type. Each of the thirty-eight warehouses is equipped with 171 sprinklers and the main station floor with 1,054 sprinklers, making a total of 7,552 Grinnell automatic sprinklers installed. The sprinkling apparatus is divided into forty-four sections. Each of the warehouses is protected by one section independent of the others, and the main floor is protected by six sections. The sprinkler alarm system consists of 44 alarm gongs, located on the first floor, one for each section, which gongs are actuated by automatic contact valves in the supply pipe lines. Each of the sections is also connected to the station annunciator located in the engine-room of the power plant, which will, in case of fire, ring the alarm gong in said section and also the gong on the annunciator, the drop on the annunciator indicating the location of the sprinkler that opened. The sprinkler system is also connected up with six Siamese steamer connections for water supply from the city fire engines.

The water for the plumbing system for the warehouses is distributed from two 15,000 gal. tanks on the roof of the warehouses. The two house pumps furnishing water to these tanks are located in the engine-room and are of the direct-acting center-packed-plunger type, each of 250-gal. capacity per minute. The suction for these pumps is taken from the two overhead tanks located on the second floor of the engine-room, and the discharge pipe from pumps to the warehouse tanks is run through the tunnel.

The entire electrical and mechanical equipment of the warehouse plant and also the power plant, was designed by Kindl & Glafey, now Glafey & Plagwitz, consulting engineers, of Pittsburg. Mr. Eric Plagwitz was engineer in charge of construction. Mr. Charles A. Bickel, Pittsburg, was architect and engineer in charge of the design of the structures.

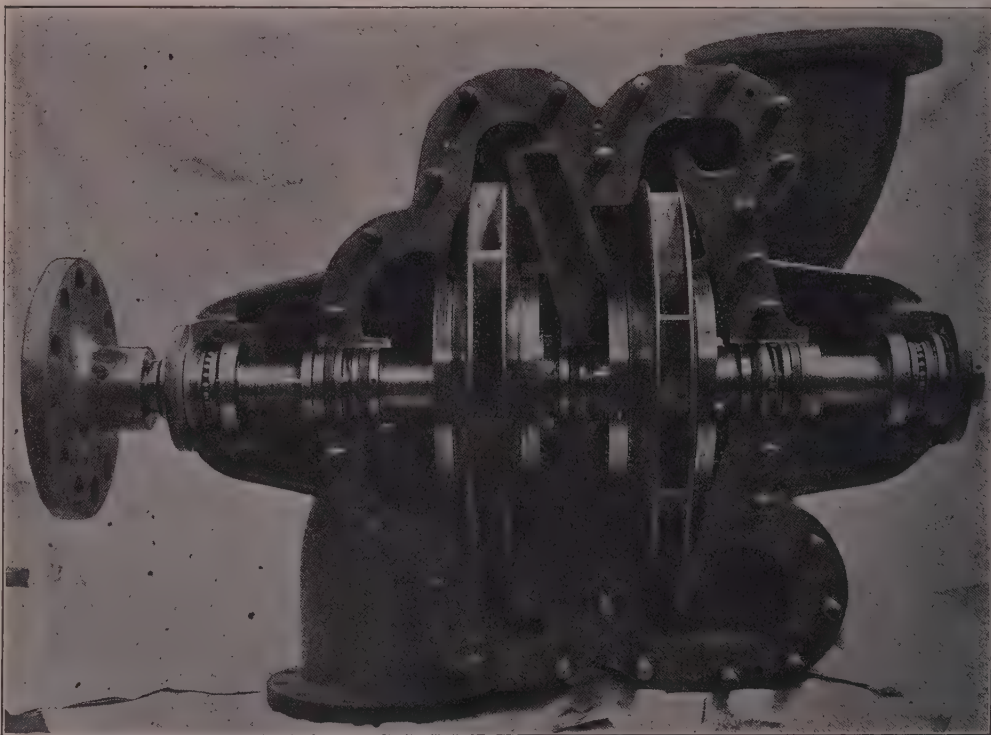
ENGINE VIBRATIONS have been overcome by a special foundation built for a 20-h.-p. gas engine driving a 12½-kw. lighting dynamo in a London house. The foundation consists of a 5-in. bed of concrete on which were laid ten 3 x 4½-in. timbers, spaced 6 in. apart. A series of 2-in. holes were bored in the top of each timber, and in these holes were inserted powerful helical springs, capable of carrying 500 lb. with ½-in. compression, there being forty-eight springs in all. These springs support, a galvanized-iron tray, 10 ft. long by 5 ft. wide, which contains a concrete base, 2 ft. 8 in. thick, upon which the engine is erected. The exhaust and compressed air connections to the engine are of flexible metallic tubing while all other piping connections are made through rubber hose. When the engine was started on this foundation, it was found that the vibration had been eliminated, but a slight longitudinal swaying of the engine was noticed at first. This vibration was prevented by locating a timber guide at either end of the spring supported platform, since which the outfit is said to have operated absolutely without noise. This is a simple and easily-constructed form of cushioned foundation, but has the disadvantage that it is applicable to comparatively small units only.

Tests of a New Centrifugal Pump.

For about two years Messrs. Julius Degen and E. S. Lea, of Trenton, have been conducting experiments with a view to increasing the efficiency of centrifugal pumps and at the same time reducing their manufacture to a better commercial proposition by designs which will enable one set of patterns to be used for a large number of conditions. It is stated that approximately 150 sizes and capacities of pumps can be obtained from ten sets of patterns, while the efficiency of the new design is shown by the following abstract of a report by Prof. J. E. Denton, on tests made by him in June and July.

The general design of the pump tested is shown in the accompanying illustration. It consists essentially of two shrouded runners mounted on the same shaft in a double case. This case is partitioned so that the water is drawn from the source of supply and put under pressure by the first wheel, and then delivered to the suction chamber of the second wheel. The second wheel

packing is used for both the suction and discharge ends and for the intermediate sections. The cup leathers are held against a flat collar, on extended pump-wheel sleeves, in such a manner that the leathers can follow up as they or the collars are worn, or the shaft may be shifted at will in either direction, with the leathers following, without changing the location of the leather with relation to the shaft collar. A spiral spring is used between each pair of cup leathers, to ensure their seating against the collars before pressure is put on the pump. Provision is made for setting out the leather packing on the suction end of the shaft by the water pressure of the high side of the pump. On the outside of the main bearings, at each end, is placed a ball thrust-bearing, with adjusting collars, for shifting the shaft endways to balance the end thrust of the pump runners. The balancing is accomplished by means of variation in the width of water space, on both sides of the wheels between the rim of wheel and the case. Experiment showed that as the wheel was moved laterally



General Design of Centrifugal Pump.

then imparts to the water the same amount of energy, it receives from the first wheel, thereby increasing the pressure, and then delivers the water into a spiral discharge conduit terminating in a diverging nozzle connecting with the main pipe. The suction and discharge pipes have a diameter of 10 in., and each wheel has an outside diameter of 24 in. and is fitted with eight blades.

The special features of the pump are described by Prof. Denton substantially as follows: The case is divided through its horizontal diameter by bolted flanges so that its top half can be quickly freed and lifted off, without disturbing either suction or discharge connections, thereby affording easy access to the internal parts of all the stages at once. By means of bolted circumferential divisions of the case, provision is made for either using the suction and discharge end of a case together as a single-stage pump, or for adding as many intermediate sections as may be necessary to afford any desired pressure at any fixed speed. Additional stages can therefore be installed after a pump has been in operation without wasting any parts of the existing case. A special arrangement of double cup-leather

in the case, the pressure between the wheel and case increased on the side where the clearance was greatest, and was reduced on the opposite side.

The pump was driven during the test by an electric motor directly connected to the pump shaft. It was arranged to lift water by suction, about 7 ft., and to deliver it through a 10-in. throttle-valve and a 6½-in. bell-shaped nozzle to a weir tank, about 25 ft. long by 10 ft. wide and 10 ft. deep, whence the water flowed through a rectangular notch 3.02 ft. wide in a ¼-in. beveled iron plate set in the middle of the end of the tank about 7 ft. above the bottom. A pitot tube was applied under the nozzle, and its indications used as a means of quickly adjusting the discharge of pump to the several amounts of flow necessary for the tests. The amount of water flowing was calculated from the weir height by the Francis formula. The weir heights were taken with a hook-gauge in a barrel communicating with the tank by an inch pipe having an open end square with the flow of water at a point 13 ft. back of the notch. The surface of the water approaching the weir was made perfectly smooth by means of a grill lattice 6 ft. from the discharge

nozzle, and by using dam-boards set by experiment.

The zero of the hook-gauge was determined daily with a straight-edge, and checked by a surveyor's level. Readings of the gauge could be easily made to 1/64 in. The leakage of the weir was frequently determined. It remained practically constant at 18 gal. per minute, which was added to the quantity calculated by the weir formula.

The total lift of the pump was determined by adding the vacuum shown by a mercury gauge on the suction pipe close to the pump to the pressure above the atmosphere at a point in the discharge pipe close to the pump, the pipe diameter being the same at both points. Both a pressure gauge and a mercury tube were used on the discharge pipe during most of the tests, the gauge

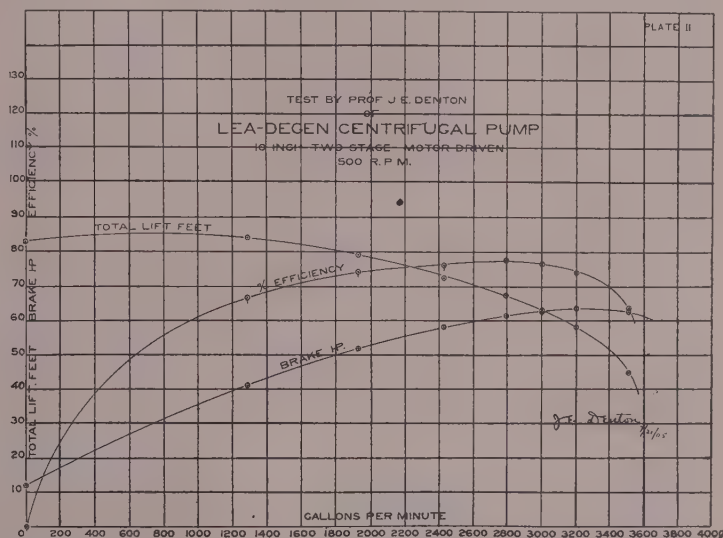
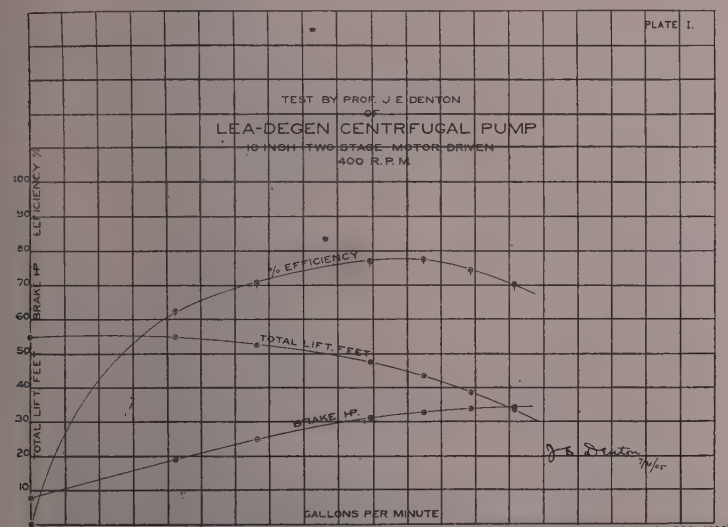
by a rheostat, and the required data were observed at 5-minute intervals until the average of the readings was practically constant. The throttle-valve was then reset to secure a series of reduced rates of flow, which, by preliminary tests, were known to be sufficient to establish the "gallons-lift curve" shown in the diagrams. No data were recorded at a speed varying more than two revolutions from the assigned speed, a skilled assistant devoting his attention to this point. After the "gallons-lift" curves were secured, the pump was disconnected from the motor, and the power of the latter absorbed by a Prony brake over the same range of watts applied to drive the motor during the pump tests. Thereby brake horse-power watts curves were established, from which the horse-power corresponding to

nipple in the top block, through a long vertical flexible hose, and a hand-tightening wheel, with a leverage of 1,000 to 1, enabled the highest loads to be maintained indefinitely with a very steady equipoise of the scale-beam.

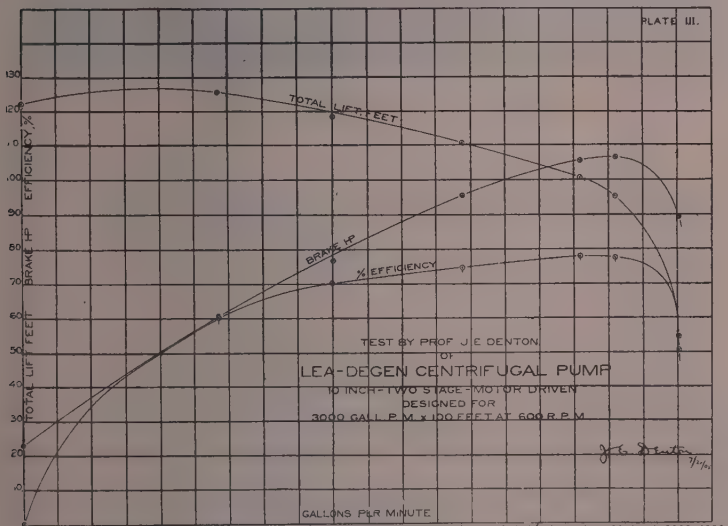
The tests show that the pump afforded the following results under conditions of maximum efficiency.

R.p.m.	Efficiency.	Capacity.	Lift.
400	77.7%	2,296 gal.	43.6 ft.
500	77.6%	2,794 gal.	67.4 ft.
600	77.97%	3,235 gal.	100.7 ft.

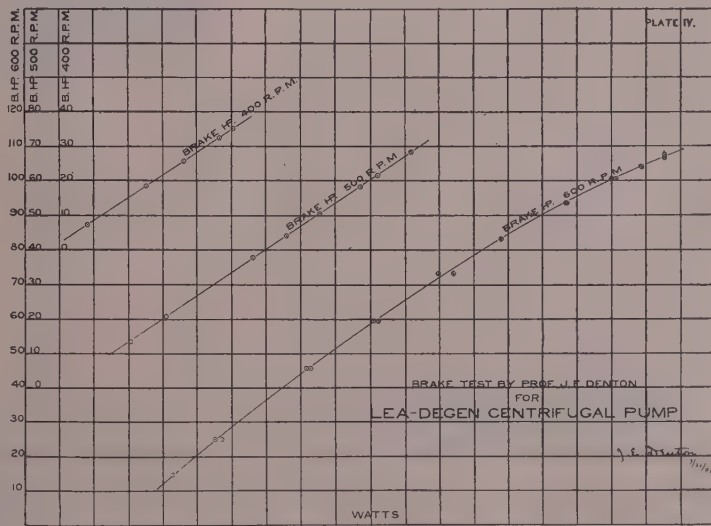
In round numbers, therefore, the capacity at maximum efficiency is directly proportional to the revolutions, and the lift, or head, is proportional to the square of the revolutions. At each speed the efficiency averaged more than 76 per cent.



Two Efficiency Tests of Motor-Driven Centrifugal Pump Operating at 400 and 500 r.p.m., Respectively.



Efficiency Test of Centrifugal Pump at 600 r.p.m.



Power Required at Different Speeds.

being calibrated by a Crosby testing apparatus. Special precautions were taken to have the inside of the main pipe smooth at points selected for measuring the pressure.

The pump was designed for practically equal efficiency through a range of speed between 400 and 600 r.p.m.; therefore an efficiency test was made at 400, 500 and 600 revolutions, respectively. At each speed the steps in the determination of the maximum efficiency were as follows:

The pump was primed with the throttle-valve closed. The valve was then set wide open, and a connection made with the mercury-columns, which had been previously filled with water between the mercury and the cock connecting them to the main pipe. The speed was then adjusted

the watts applied to drive the motor during the pump tests was determined, and taken as the horse-power to drive the pump. The useful work of the pump, or the water horse-power, is equal to the pounds of water delivered per minute, multiplied by the total lift in feet and divided by 33,000. The efficiency is, then, the water horse-power divided by the horse-power to drive pump.

The Prony brake was of the two semi-circular, solid-block type applied to a 28-in. pulley, with a 6-ft. lever-arm acting on a knife-edge on a tested platform-scales. It was carefully balanced, with its pulley, by mounting the whole combination, with a mandril through the pulley, on straight-edges. A copious stream of water applied to a

over a range of 600 gal. of capacity for the lower two speeds, and 900 gal. at the higher speed, the head remaining nearly constant.

Pipes tapped into the case, on either side of the high wheel, were connected to the two ends of a U mercury tube. With the shaft in the position in which it had been adjusted for the test, there was no difference of pressure shown by the mercury, and there was no evidence of labor in the thrust bearings for this position during the several days of operation of the pump for the tests of efficiency. When the shaft was moved 7/32 in. laterally from this position, the mercury showed an excess of pressure of 7/8 in. on the side of the wheel upon which the clearance had been increased.

The Long Lake Highway Bridge.

A highway is carried across Long Lake, Hamilton Co., N. Y., by a steel truss bridge with a main span of unique design which is of interest on account of the special features and construction as well as because its length of about 520 ft. clear span places it among the very longest of such structures. The bridge consists of a span of 170 ft. and another of 525 ft. on centers with their adjacent ends about 200 ft. apart seated on opposite shores of a small island. The two spans are not in line and their axes intersect at the abutment of the long span.

The main span, 525 ft. long on centers, has a back through trusses, 16 ft. apart on centers, and is of ordinary construction with a floor proportioned for a uniformly distributing load of 100 lb. per square foot carried on seven lines of 7-in. 15-lb. I-beam stringers resting on the top flanges of 15-in., 42-lb. I-beam floor beams, 17 ft. apart on centers. The top chord has a uniform cross-section of $12\frac{1}{2}$ sq. in. and is made throughout with two 10-in., 15-lb. channels and one $14\times\frac{1}{4}$ -in. cover plate. The bottom chord has a maximum cross-section made with two $3\times1\frac{3}{8}$ -in. bars. The diagonals extend across two panels and are connected at the center points to the sub-diagonals and sub-verticals supporting the intermediate floor beams with pairs of $1\times\frac{3}{4}$ -in. suspension rods. Each transverse panel is sway-braced with a latticed top strut and knee-braces and there are X-brace lateral rods in the planes of both top and bottom chords. This span weighs about 85,000 lb. and was erected in the ordinary manner on falsework.

The main span, 525 ft. long on centers, has a clear height of about 20 ft. above water level in the middle and consists of two cantilever arms and one suspended span each 175 ft. long. The trusses are in vertical planes and the top and bottom chords are both curved, giving them depths of 60 ft. at the abutments and 20 ft. in the center. The trusses are also inclined horizontally, giving the roadway a clear width of 16 ft. in the center and of 24 ft. at the abutments, thus providing for wind stresses and increasing the stability more than would have been afforded by the width required to accommodate the traffic. The design is unique in that the cantilever arms are not connected in the usual manner to anchor arms. The trusses terminate with the vertical posts at the abutments and the cantilever reactions are provided for by tension members from the tops of the end vertical posts to anchorages like those of a suspension bridge. This feature of construction reduces the weight of structural steel and secures a pleasing outline for an economical span which was easily built and erected.

The bridge is proportioned for a live load of 640 and 920 lb. per linear foot on the cantilever and suspended spans, respectively, and for a dead load of 640 lb. per linear foot on the suspended span. The dead load for the cantilever spans is not uniform and was computed in accordance with calculated amounts. The wind pressure per linear foot of the bridge was assumed at 250 lb. for the cantilever span and 200 lb. for the suspended span to be cared for by the bottom lateral system, and at 150 lb. throughout to be cared for by the top lateral system. The resulting maximum stress together with the materials and sectional area of the members is given in the strain diagram which is reproduced as an interesting record for a long highway span. The top chord of the cantilever arms is built of eye bars of a maximum area of 22 sq. in. for the 351,000 lb. tension in the end panels. The bottom chords are made throughout with a pair of channels latticed together and varying from 10 to 15 in. in depth with corresponding sectional areas of about 9 to 33 sq. in. The suspended span has a top

chord made with two 9-in. channels reinforced in the center panels by a $14\times\frac{1}{4}$ -in. cover plate giving it a total sectional area of 11.3 sq. in. The bottom chord is made with eye-bars in the center panels and with latticed struts in the end panels.

The end vertical posts are pin connected at the bottom to riveted pedestals seated on the abutment masonry with their bed plates at right angles to the resultant of the stress in the vertical post and the bottom chord. The pin at the upper end of the post engages four $5\times1\frac{3}{8}$ -in. eye-bars which make an angle of about 45 deg. with the vertical.

The island is composed of sand and gravel with no rock near the surface so that the abutment and anchorage piers are built of stone and concrete masonry supported on pile foundations. The abutment is a single pier, I-shape in plan, with two inclined wing walls and two main piers about 15 ft. in height connected by a transverse back wall 20 ft. high. The pier masonry is built in inclined courses normal to the resultant pressure from the shoe and is seated on a concrete bed enclosing the pile tops and forming a footing for the remainder of the masonry which is laid in the usual manner with horizontal courses. The

upper ends of the foundation piles and extended around the reaction platform, thoroughly sealing the enclosed steel work above described.

At the shore end of the span the abutment consists of two masonry piers and a back wall with no wing walls. The masonry is seated on the sound bed rock to which each pedestal is secured by four anchor rods engaging at the upper ends the riveted shoes. The latter are secured like those at the opposite end of the bridge by horizontal ties, which in this case are not enclosed, and consist of four $2\times\frac{7}{8}$ -in. rods about 9 ft. long for one panel and 10 ft. long for the other panel. The shore ends of these bars have sleeve nut connections with $1\frac{1}{2}$ 13/16-in. round rods bent close to the sleeve nut and firmly leaded into holes 3 ft. deep drilled in the solid rock normal to the surface.

The backstays at this end of the bridge are each made with two 27-ft. 4-in. lengths of eye-bars connected at the lower end to 21-ft. 4-in. lengths of $3\times1\frac{1}{2}$ -in. bars, eight in all, provided with sleeve nut adjustments near the lower end. These rods are arranged in groups of four and each group is connected at the lower end to a pin through an ordinary two-web riveted shoe seated on a low masonry pier built with its in-



Erection of Main Span.



Cantilever Span With Sleeve Anchorages.

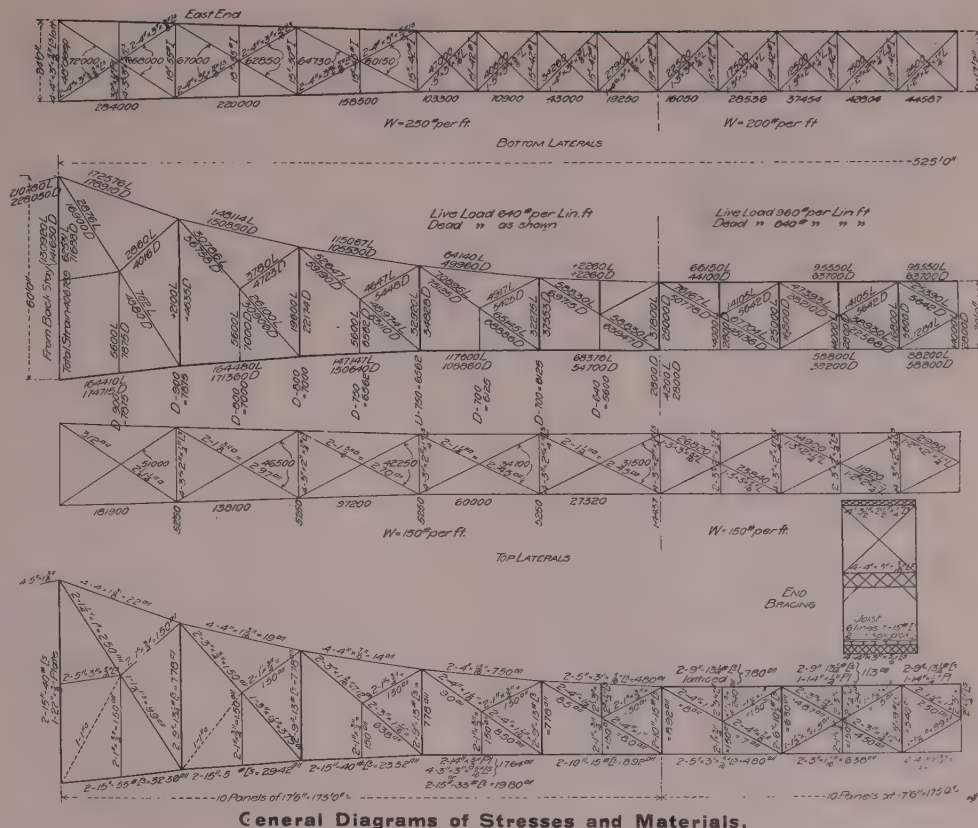
pedestal is also secured by a pair of $10\times\frac{5}{8}$ -in. horizontal tension bars built into the abutment masonry and each connected at the back face with two $2\times\frac{7}{8}$ -in. inclined anchor rods with sleeve nut adjustments. The lower ends of these rods engage a transverse horizontal pin bearing against a pair of track rails 3 ft. long bedded in the sand and gravel to form a reaction platform.

At the same end of the span the main tension bars or back stays from the top of the vertical posts are made in three 27-ft. 4-in. lengths engaging at the lower end two riveted members $30\frac{1}{2}$ ft. long, each made with a pair of $6\times6\times\frac{3}{4}$ -in. angles, as shown in the accompanying detail. These angles are riveted to shoes bearing on the bottom flanges of horizontal rails which distribute the pressure on the under side of inclined courses of cut stone built into the lower corner of the anchorage pier. The latter contains about 250 cu. ft. of masonry in which the riveted members are sealed as nearly air-tight and water-tight as possible. The two piers are 20 ft. 9 in. apart on centers and are supported directly on the soil at the front ends, and at the rear ends have concrete footings enclosing the

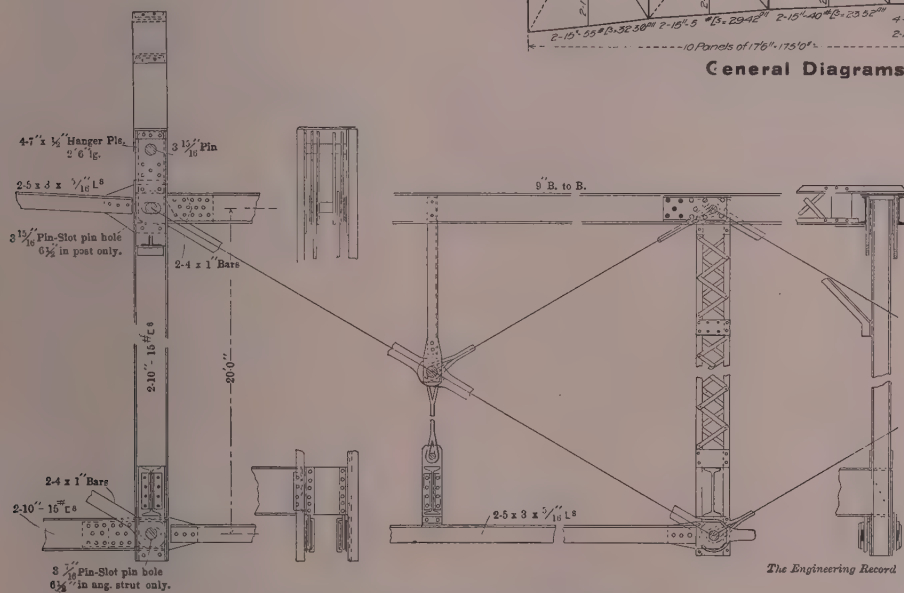
inclined courses parallel to the backstay and with the footings racked off to give normal pressure throughout on the surface of the rock. The pin in the shoe engages the upper end of a chain made with two $10\times\frac{5}{8}$ -in. plates in two lengths pin-connected together and pin-connected at the upper ends of a pair of $6\times1\frac{3}{16}$ -in. vertical eye-bars, about 18 ft. long, bolted together with outside lugs to increase their bond in the anchorage. These eye-bars are set in 8-in. holes, machine drilled to a depth of 22 ft. in the granite rock. The walls of the drilled hole have corrugations about 8 in. apart occasioned by the successive sharpenings and flangings of the drill points, and these are considered to provide sufficient irregularities to key the neat Portland cement grout with which the holes are filled around the anchor bars. This method of anchorage is considered satisfactory under these circumstances and proved very much cheaper than the gravity piers at the opposite end of the bridge.

The 175-ft. center span trusses are suspended by double pairs of $7\times\frac{1}{2}$ -in. vertical hanger plates connected at the lower end to the end top chord pins and at the upper end to pins passing through

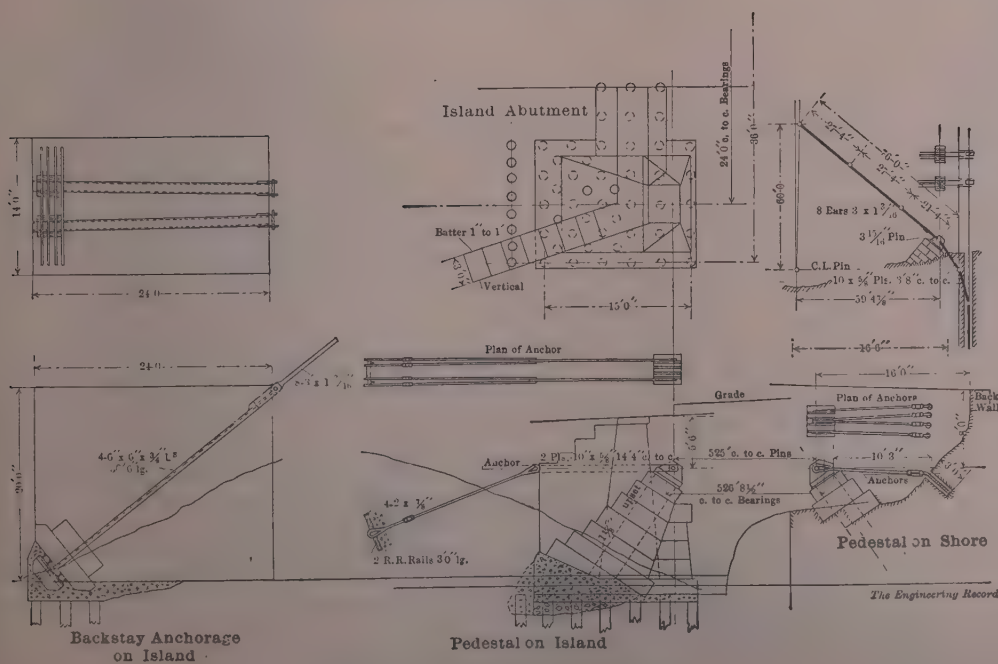
the tops of the end vertical posts of the cantilever arms 18 in. above the centers of the top chords. These links are arranged between the webs of the vertical posts which have slotted holes for the lower pin, thus enabling it to move back and forth about $2\frac{1}{2}$ in., and providing an expansion joint. The end bottom chord pins of the center span engage holes through all the members of both trusses at this point, slotted in the vertical posts only. The floorbeams at main panel points pass between the webs of the vertical posts and have their lower flanges seated on the edges of the flange cover plates. The intermediate floorbeams at sub-panel points are suspended from the intersection of the sub-vertical and sub-diagonal members with the main ties. The suspension rods engage pins through the upper ends of $6 \times \frac{1}{2}$ -in. vertical hanger plates riveted to the floorbeam transverse to its web and projecting below the bottom flange with a short horizontal angle riveted to it to take bearing on the upper edges of the lower chord bars. The vertical posts at the river end of the cantilever arm is made with two 10-in. channels having their webs parallel to the bridge axis. The floorbeam is web-connected to the inside channel just clear of the bottom chord and the channel webs are connected by a diaphragm plate in the plane of the floorbeam web.



General Diagrams of Stresses and Materials.



Details of Suspended Center Span.



Pier and Anchorage Masonry.

The sub-structure was built in the winter and the measurements for its location and for the length of the super-structure were made on the ice. The super-structure was erected in the following summer by a method practically eliminating falsework for the main span, the cantilever arms of which were built out panel by panel from shore, the reactions being taken by the back stays. The work was done by a small party of men who erected the two cantilever arms successively and afterwards erected the center span and floated it to position on trestles supported by a raft of kerosene barrels. Small rafts of a similar construction were placed alongside the main raft to carry the lower ends of inclined braces reaching to the top of the trestle. This 40-ton span was floated approximately into position and the pin connections made without any difficulty. The entire erection work was accomplished in about four months at an approximate cost of \$15 a ton, an amount which would have been materially increased if the wages now current had been paid for labor.

The total amount of steel in the cantilever span is about 220 tons. The structure was designed, fabricated and erected by the Owego Bridge Co., Owego, N. Y., Mr. C. S. Mallory, chief engineer. According to the laws of the State of New York all town bridges of 100-ft. span or more are subject to the approval of the state engineer and surveyor who, in this case, was represented by Mr. C. O. McComb, of Watertown, N. Y.

THE TWO AND FOUR-CYCLE GAS ENGINES have about the same relative power for engines of the same size and of the best possible construction, when operating at average speeds. For piston speeds above 700 or 800 ft. per minute, the four-cycle engine will develop considerably more power than the two-cycle and at the highest practicable speeds will develop about 25 per cent. more power. At low piston speeds, 500 ft. per minute and less, the two-cycle engine will frequently develop 50 per cent. more power than the four-cycle engine of similar size, the reason being that, if operated slowly enough to permit of proper scavenging and recharging, much more power is produced by explosion each revolution.

The Decomposition of Cements in Sea Water.

Some time ago Mr. H. Le Chatelier, of France, was invited by the International Association for Testing Materials to present a general review of the investigations that have been carried out on the decomposition of hydraulic cements in sea water. On attempting to collate the required material it was quickly discovered that but little precise information was available on this important subject, he said in his report made at the recent congress of that Association, so that he would only give a sketch of the laboratory experiments that he has made made himself during the past few years.

This sketch is really of considerable length and sets forth quite clearly Mr. Le Chatelier's opinions as to the causes of the decomposition of cements in sea water. If chemical reactions are the primary cause of the hardening of cements, it does not necessarily follow, according to his report, that all the reactions which take place amongst the products should have the same effect. On the contrary, there are cases where chemical reactions lead to the disintegration of cement. They do this in two totally different ways, he says, fraught with very unequal degrees of danger. The reactions may simply bring about a softening of the mass through a formation of compounds having a gelatinous consistency, the

ium sulphate and the calcium compounds of cement reacts with calcium aluminate, it produces a calcium sulph-aluminate whose crystallization gives rise to swelling and cracking in the material. The action resembles that consequent upon the hydration of quicklime, but is much slower.

3. Penetration of marine salts takes place in two different ways: Sea water penetrates en masse through all the flaws in the joints of the masonry and through the crevices in the stones and brick themselves. Most of these flaws in workmanship are unavoidable. From the present aspect, the normal porosity of cement plays only a secondary part in the process.

Afterwards, when the cement is sound, circula-

Bits	Drill Mchs	Hoists
Trinity Building Address 111 Broadway New York		

Fig. 7.

Bits	Drills	Hoists	SinkerBs	Tool Chest
Trinity Building Address 111 Broadway New York				

Fig. 8.

Name No. 6 Vulcan Chain Tongs-No. 75.	
Purchased from John Smith Co.	
Date	Nov.-1904.
Cost	\$7.35
Inventory	1905-\$6.62
Lost on Trinity-1905.	

Fig. 1

Name Tool Chest No. 10 and contents	
Purchased from Mis. See book A page 40.	
Date	July, 1903.
Cost	\$137.06
Inventory	1904, \$120 \$17.45 \$4.50; 1905; \$110. \$10.54 \$14.75 \$19.20; 1906-\$75.

Fig. 2

Name No. 14 Jump Drill Machine.	
Purchased from Factory, Shop Order 4,769.	
Date	Jan.-7-06.
Cost	\$210.25.
Inventory	1906-\$200.

Fig. 3

Method of Indexing and Transferring Tools.

Name No. 6 Vulcan Chain Tong: No. 75.	
Transferred from Storeyard.	Date Nov. 1905.
to North River.	" 11-1-1905.
to Trinity	" 11-20-05
to	"
to Lost, 1905.	"
to	"
to	"
to	"
to	"
to	"

Fig. 4

Name Tool Chest No. 10 and contents	
Transferred from Storeyard.	Date July, 1903.
to Wanamaker.	" Aug. 3, 03.
to Hotel Gotham.	" Jan. 10, 04.
to Trinity.	" Nov. 11, 05.
to U.S. Express.	" Apr. 22, 06.
to Storeyard.	" Sep. 7, 06.
to	"
to	"
to	"
to	"
to	"

Fig. 5

Name No. 14 Jump Drill Machine.	
Transferred from Factory.	Date 1-7-06.
to Storeyard.	" 2-9-06.
to Tribune Bldg.	" 3-27-06.
to U.S. Express.	" 6-1-06.
to West St. Imp. Co.	" 8-20-06.
to	"
to	"
to	"
to	"
to	"

Fig. 6

Cards Used in Indexing Location and Transfer of Construction Tools.

cement then losing its hardness and succumbing easily to mechanical agencies which attack it from the exterior—more particularly the action of the waves—although its general appearance remains unchanged; or they may be accompanied by swelling and cracking until the material is wholly destroyed. These two ways of disintegration which Mr. Le Chatelier has investigated in detail, are quite fully discussed in his report in which he draws the following conclusions from a chemical point of view regarding the decomposition of hydraulic cements when exposed to sea water.

1. All the active ingredients in cements: lime, aluminates, and silicates, are decomposed immediately they come into direct contact with the magnesium salts of sea water, yielding soluble chlorides and sulphates of calcium, and so bringing all the lime present into a state of solution.

2. When the calcium sulphate found in natural waters or formed by the interaction of magnes-

tion of, and attack by, sea water occurs almost exclusively by a process of diffusion, being the more rapid as the normal porosity of the cement is the greater.

4. All the phenomena of decomposition in sea water are at the mercy of a superficial film of extreme tenuity, whose impermeability tends to prevent, or rather to hinder, diffusive action, but whose expansion, caused by the formation of calcium sulph-aluminate, promotes swelling of the material and cracks through which the salt water soon penetrates in quantity.

THE LOCOMOTIVE TESTING PLANT which the Pennsylvania R. R. had in operation at the Louisiana Purchase Exposition, has been moved to Altoona, Pa., and set up in the shops of the railroad at that point. The first locomotive trial was made on it Aug. 8. The plant occupies a 47x154-ft. stone building and embodies a number of recent improvements.

A Method of Indexing and Transferring Construction Tools.

Keeping a reliable and accurate record of tools used by construction companies on different contracts situated in various parts of the country, or in different parts of the same city is extremely important and not an altogether easy task. Mr. Clifford R. Harris, of the Standard Plunger Elevator Co., has supplied the following notes and illustrations regarding a system of indexing and transferring construction tools which he has devised, after having had experience with keeping such records in books and on indexed cards,

which were unsatisfactory from one point of view or another. This system, which has been employed by the Standard Plunger Elevator Co. for a year, has been found better than any previously used by that company and no change has been suggested from the experience with its use.

This system was devised with a two-fold object; first, to know how many tools of each kind were owned by the company and their value, which is termed the inventory record; second, where each tool was located, which index is called the transfer record. The fundamental principal underlying the system consists in having each tool represented by a card for each index. So long as each card in the transfer record represents but a single tool, the card can be moved the same as the tool is, from job to job.

Figs. 1, 2 and 3 show an inventory card, respectively, for a No. 6 Vulcan chain tongs, a tool

chest and jump drill machine. It will be observed that on Fig. 11 a note stating this tool was lost on a job and, of course, all such cards are kept under a separate guide card and the value of such tool as shown on the card charged to that particular installation. Fig. 2 shows a chest containing a lot of miscellaneous hand tools and the value of these tools at various inventories. Entries are made as new tools are added to the chest after the inventory for that year. An exact list of all tools which should be in this chest is kept in a book and a similar list is pasted on the inside of the chest cover. Fig. 3 shows a jump drill machine manufactured at the factory for the company's use.

Figs. 4, 5 and 6 show the regular transfer cards and the wanderings of the various tools from job to job.

These cards are kept in regular 3x5-in. index drawers, and at the present time 24 drawers are necessary to carry all the cards. The inventory records are kept in alphabetical order behind three division guide cards as shown in Fig. 7. The transfer cards are kept behind five division guide cards on large contracts, with a three division card denoting the contract. Fig. 8 shows these guide cards. On small contracts no attempt is made to sub-divide the tools, all cards

fer cards corresponding with the orders he has issued.

This system may look somewhat complicated, but by its use Mr. Harris says tools can certainly be traced and accurate records kept of their movements and location.

Progress on the New York State Barge Canal.

Mr. A. B. Fry, chief engineer of the New York State Treasury Department, and a member of the consulting engineer's board for the new New York State barge canals, has recently issued the following memoranda, concerning the estimates, awards of contracts, and so forth.

The total amount of contract work for which plans and specifications have been prepared by the State Engineer's Department, and passed on and approved by the Advisory Board of Consulting Engineers, up to September 1, 1906, is \$22,644,418. There has been actually let twelve contracts, on which work is now proceeding, as follows: Erie, seven contracts, aggregating \$5,866,285; Champlain, three contracts, \$2,825,347; Oswego, one contract, \$1,126,718. There has also been let one contract for work common to both

Regulations of the Engineering Bureau, Board of Water Supply, New York.

The regulations prepared to insure uniform and correct methods in all departments of the Engineering Bureau of the Board of Water Supply of New York City have recently appeared in the form of a 114-page book. In a letter transmitting the regulations to the members of his staff, Chief Engineer J. Waldo Smith points out that some detailed regulations will have to be determined by each department engineer for the peculiar requirements of his work, but whenever such special rules are necessary, they are expected to harmonize with the general instructions. The latter are unusually complete, and explains the general organization of the Bureau as well as the duties of its several grades of employes and the standard methods for them to follow. It is impracticable to publish many of these regulations in this place, but a few of them are given in order that other engineers may see how far their own practice confirms with that of the latest great engineering bureau to be organized.

Standard Sizes and Forms.—Standard sizes for stationary, drawings, etc., have been established

JOB WestSt DATE 7-9-06

BLANK ENGINEERING COMPANY

The following tools are needed at once on above job
Henry Blank Foreman

1	3 coils 1 3/4 in. drill rope
2	4-10 ft x 5 1/2 in. sinker bars
3	10 Swivel heads
4	2 Strings 14 in. rotary tools
5	3 extra long 14 in. bits
6	4 prs No. 6 Vulcan chain tongs
7	3-20 h.p. motors for 110 volts
8	6 Drill machines
9	5 Tool Chests
10	6 Shovels
11	10-25 lb sledges
12	4-8 in. Hammers
13	2 Sinker Bars 6 ft x 5 1/2 in.
14	1 coil 3/4 in. rope
15	1 Sand Bucket

(This form printed on 6x9 in. paper)

Fig. 9.

JOB Trinity DATE 7-10-06

BLANK ENGINEERING COMPANY

From your supply of tools you will furnish
and ship immediately via team the
following tools to WestSt corner Albany
Frank Jones, Tool Supt. New York

1	2-20 h.p. 110 volt Motors G.E. No. 20457, C+C No. 14832
2	2 Drill Machines Nos. 3, 10
3	2-6 ft x 5 1/2 in. sinker bars
4	1 Coil 3/4 in. rope
5	1 Sand Bucket
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	

(This form printed on 6x9 in. paper)

Fig. 10.

JOB Storeyard No 435

BLANK ENGINEERING COMPANY

The following tools from Storeyard DATE 7-10-06
were transferred } To WestSt Job
John Smith FOREMAN

1	3 coils 1 3/4 in. drill rope
2	4-10 ft x 5 1/2 in. sinker bars
3	10 swivel heads
4	2 strings 14 in. rotary tool
5	3 extra long 14 in. bits
6	4 prs No. 6 Vulcan chain tongs Nos. 43, 76, 81, 5
7	1 G.E. Motor No. 76875-110 Volts 20 h.p.
8	4 Drill machines Nos. 6, 13, 21, 27
9	5 Tool Chests Nos. 10, 13, 18, 19, 23
10	6 Shovels
11	10-25 lb Sledges
12	4-8 lb Hammers
13	
14	
15	(This form printed on 6x9 in. paper)

The above tools received at WestSt job
Date 7-10-06 Henry Blank FOREMAN
Note-Date, sign and return to Tool Supt.

Fig. 11.

Forms Used in Ordering and Recording Transfer of Tools.

being placed behind a single three division card. It must be evident that some scheme has to be employed to convey information of tool transfers from the jobs to tool superintendent. One man must be employed who is responsible for all tools and their location. If any outside foreman or superintendent wishes a tool a requisition must be sent to the tool superintendent. This may be over the telephone or in writing. If done over the telephone it must be confirmed in writing. Fig. 9 shows such a form. Upon receipt of such a request the tool superintendent fills out, in duplicate, blank as shown by Fig. 10. The copy he keeps and the original goes to job, from which the tools are to be transferred. Upon receipt of Form 10 the foreman on that job makes out transfer slip, Fig. 11, in quadruplicate, on different colored paper. One copy, together with Form 10 after being signed, goes to the tool superintendent, and two copies to the job which requires more tools. When the tools arrive on the latter job this foreman files one copy, signs and sends the second to the tool superintendent. Upon receipt of these slips the tool superintendent has a complete record that tools have been transferred as ordered. Of course, the tool superintendent moves the trans-

the Erie and Champlain canals amounting to \$97,635. On one contract, No. 12, Erie Canal, the engineer's estimate for which was \$1,329,635, no bids were received and it is probable that limits and certain conditions affecting this contract will have to be modified before it is again advertised. There are now in the hands of the Canal Board plans and specifications governing six contracts, which are now ready for advertising, the engineer's estimates under these contracts aggregating \$11,245,293. The State Engineer's Department has nearly finished plans and specifications for twelve additional contracts on the three canal systems, heretofore named, and it is expected that the work for them may be let before the close of the current year. Should this prove practicable, more than one-third of the entire work of construction of the three canals would be let by January 1, 1907. Thus far, the work actually contracted for and now under way has been let at prices averaging 10 per cent. less than the original estimates, and appropriations made under the Barge Canal Act of 1903.

for universal use. Departure from standards may be made only by permission from the headquarters office, and for sufficient reason. Papers not of a standard size should, if possible, be cut or folded to a standard size for filing; if too small, they may be mounted on standard sheets. These standard sizes are as follows: 3 x 5 in., index cards, memoranda, reference lists on cards. 5 x 8 in., field notes, record cards, printed specifications and many printed forms, and pamphlets for field pocket use. 5 x 15 in., 22 in. and 29 in., allowing for punching for rings in note cover, and 8 x 10 in., 15 in., 20 in., 25 in., approximately, to be folded to 5 in. x 8 in., for diagrams, tables and drawings to be used in field note covers or otherwise with 5x8-in. papers. 6 x 9 in., printed reports and other books or pamphlets. 8 1/2 x 11 in., letters, computations, official photograph mounts, and many printed forms. 8 1/2 x 14 in., traverse sheets, estimates for contract payments, expense accounts, leases and legal forms. 11 x 8 1/2 in., 13 in. and 18 in., sketches, diagrams, tables and small drawings to accompany computations, letters or reports.

26 x 40 in., 20 x 29 in., 14½ x 20 in., drawings of all kinds. It is intended that by far the greater number of contract and working drawings shall be 20 x 29 in.

Real estate and topographical maps will be mostly 26 x 40 in.

19 x 24 in., green cross-section sheets to be used for estimates and other purposes.

Filing and Indexing Letters, Reports and Other Communications.—Letters, reports, etc., are filed in letter size, four-drawer, golden oak, unit vertical files of the type adopted by Headquarters Department. File units can be placed side by side to provide any number of drawers needed as the papers accumulate. In the drawers are folders of stout manila paper, each large enough to hold about fifty papers.

The index is on 3x5-in. cards, both white and colored cards being used to make convenient distinctions to expedite search. The cards are kept in single trays or in cabinets of two or more drawers, according to the size of the index. These also are of golden oak, on the unit plan.

An out card, 8½ x 11 in., is put in a folder whenever a letter is taken out, upon which is stated when the letter was taken out and to whom it was given.

Guides or partition cards having metal tips containing labels or alphabetical or other tabs are used to subdivide the contents of a letter file drawer, to expedite the finding of a desired paper.

General Files.—Filing is done by the numerical, vertical system, under which a list of suitable subjects is established, each subject being designated by a number and its sub-divisions by letters and numbers. The folders are marked with these numbers and letters, and arranged numerically. Papers relating to any one subject or sub-division are placed on edge in the appropriate folder, in chronological order, so that when the folder is open flat with papers facing upward, the latest one will be on top. Upon each paper, when filed, should be written its file number to prevent it from ever being returned to any other than its own folder.

For purposes of filing and indexing, subjects are designated by numbers. Some subjects have no numbers, but below each on the index card is written: See, indicating that correspondence on that subject is filed in the folder to which reference is made.

Each paper will be indexed under the subject of the folder in which it is to be filed. Whenever a paper treats of, or relates indirectly to, more than one subject, cross reference cards under appropriate headings should refer to it. In case of doubt the paper should be filed under the most probable subject, and cross-reference cards made under other possible headings.

Contract Correspondence.—Correspondence concerning each of the formal numbered contracts shall be filed by itself according to the system described for the general file, using the same list of subjects so far as may be necessary. In these files each folder besides having the regular subject number shall have stamped conspicuously, Contract No. Files of two or more contracts may be put into the same drawer and separated by suitable guides, each guide being plainly labelled with the number of its contract and the name of the contractor.

Card indexes for contract correspondence likewise should be kept separate, but reference cards to information which may be for general application should be put into the index to the general file.

Special Files.—Most of the correspondence will be filed in a general file with a general index. In Headquarters office a few special files have been established and others may be added if found really necessary. A few similar special files may become advantageous in the field offices, but special files should be avoided, and with very few

exceptions personal or individual files should not be allowed. Such files are likely to lead to confusion and so spoil a good system, besides causing unnecessary duplication of work and waste of stationery.

Filing and Indexing Drawings.—One man in each office shall be held responsible for the proper filing of the drawings and he alone should be allowed to put away drawings. In each office all drawings received from other offices should pass first through the hands of a designated man, possessed of sufficient knowledge, who will see that each drawing is properly introduced into the system of filing and indexing or otherwise attended to. Drawings are to be filed in the plan cases provided for the purpose and indexed on 3x5-in. cards which will be kept in convenient

the accession sheet when they are determined. This applies to the paper drawing. The tracing of a drawing is given the number already taken, unless the drawing contains important matters not traced, or is traced on more than one tracing, or the original paper drawing is kept permanently, in which case a new number is taken for the tracing. The paper drawing should be endorsed: See tracing of same number, or: Traced partly as Acc., as the case may be. If a drawing is revised, the new drawing should be given a new accession number and date and marked: Revised from Acc., and its predecessor should be marked: Superseded by Acc. The same notes should be written in the accession sheet under remarks, and on the index cards.

BOARD OF WATER SUPPLY CITY OF N.Y.

SUBJECT Catskill Aqueduct File No. 3C.33 D
Size-Slope Computations for ACC No. A 52
Quadruplicate Line of Steel Pipe SHEET 1 TOT. IN COMP. 1
 COMPUTER John Doe CHECKED BY Chas. Smith DATE Apr. 15, 1906.

MADE IN CONNECTION WITH Studies of Economic Slopes for Catskill Aqueduct Dist. 3C

To get a curve for variations in sizes & costs of pipe to carry 575 Mgd at different slopes.
 By directions from Chief Engineer assume $C = 96$ for pipes after being in use.

Assume diam. 7½', 8½', 9½', and 10½' and compute slopes.
 4 pipes each taking $\frac{575}{4} = 144$ Mgd

Q.	Dia.	Area	V	C	S	Feet per Mi.
Mgd	Feet	Sq. Ft.	Fp. S.		$\frac{575}{48} \div D$	
144	22.3	7.5	44.2	5.04	96	0.00147
"	"	8.5	56.7	3.93	"	0.000807
"	"	9.5	70.9	3.14	"	0.000449

Formula for S above derived as follows

$$V = C \sqrt{RS} \quad R = \frac{4FF}{2\pi r} = \frac{C}{2} = \frac{D}{4}$$

$$S = \frac{V^2}{C^2 R} = \frac{V^2}{(96)^2 \frac{D}{4}} = \frac{V^2}{(48)^2 D} = \frac{V^2}{2304 D}$$

Typical Sheet Used in Making Computations.

cabinets. Cases and drawers will be numbered.

Besides bearing a case and drawer number to show where it is filed, each drawing will be given an accession number which will distinguish it from all other drawings and consequently be the convenient and certain designation for the drawing in computations, correspondence or conversation. Accession sheets will contain complete description and record of every drawing made or acquired by an office of the Bureau for permanent filing. There is a double space across the accession sheet for each drawing.

An accession number shall be given to a drawing as soon as it is well started—at any rate as soon as any computations are made relating to it. The exact title and description can be filled out on

Temporary accession sheets, properly numbered on the line for each drawing, will be kept in each drafting office, on which the draftsmen can make entries as needed. When a temporary sheet is filled, a new sheet properly numbered in advance will be substituted. The filled sheet should promptly be checked and corrected, and then sent to Headquarters or some other office having a large flat-plate typewriter, where it will be neatly copied in triplicate. One copy, with the original, will be returned, the second sent to the appropriate department office and the third retained at Headquarters. These copies will be kept in suitable loose-leaf covers. After filing the final accession sheets and copies, the temporary sheets may be destroyed.

As soon as a drawing which is to be kept permanently in any Board of Water Supply office is received from some other Board office, it is to be indexed under its original accession number and not reaccessioned. Each drawing therefore will bear but one accession number by which it can always be identified in whichever office it may be.

The accession number is to be put in ink on each drawing in its lower right corner. The entry is to be made on the accession sheet, as directed below.

Under Title, write the title of the drawing in full, excepting the two lines which appear on all drawings made in Board offices: City of New York. Board of Water Supply. Under Description, write, briefly, enough about the drawing to tell what it shows. Do not repeat what is in the title, but supplement it. Abbreviations which can be readily interpreted, may be used here. In the column headed Purpose of Drawing, use the following abbreviations: L, land plan, or map; P, preliminary drawing, or study; C, contract drawing; W, working drawing; E, estimate cross-section, progress diagram or similar drawing; R, record drawing (of completed construction work); Z, foreign drawing used for reference. Under Kind of Paper and Size in Inches, use the following abbreviations on the upper line and on the lower line write the outside dimensions of the drawing: W, white paper; B, brown paper; T, tracing cloth; T P, tracing paper; W P, white print; G P, gray or green print; B P, blue print; Black, black print; Lith, lithograph; Cr-Sec, cross-section paper or cloth; T Cr-Sec, tracing cross-section paper or cloth; Pro, profile paper; T Pro, tracing profile paper; Neg, Vandyke negative; M, mounted on cloth (to be written after other designation).

The different departments will be designated by letters in filing, indexing and accessioning drawings, and will have colors given for distinguishing index cards. Foreign drawings, meaning those originating outside of this Board's jurisdiction, will be designated by an X. Divisions will use their department colors and be designated by letters. Each department office and each division will accession all its drawings independently, each having a series of numbers beginning at 1; but each department office will place before the number its department letter. Each division will place its division letters before its number. Thus: 491, S5440 and F721 indicate drawings originated in the Headquarters, Southern Aqueduct and Filtration Department offices respectively, and NE299 is the accession number of a drawing originated in one of the offices of the Esopus Division of the Northern Aqueduct Department. Division offices will supply section offices with accession numbers by sending temporary accession sheets properly numbered in advance. Section office drawing will be accessioned as though they originated at division offices; that is, a section office will not have an independent series of numbers, but will use blocks of numbers in the division series.

Computations.—For survey computations, such as stadia notes and traverse tables, and for estimates for payments under contracts, special sheets are provided.

Each assistant engaged upon general computations will be furnished with an individual computation cover holding standard punched computation sheets, $8\frac{1}{2} \times 11$ in. in size, with printed blank heading. All general computations must be made in ink on these sheets, using one side only, except as otherwise directed by a department or division engineer. The margin on the left of each sheet must be kept blank. This will make it possible to get a print of any sheet, if needed, and thus save copying. Computers are expected to provide themselves with fountain

pens for black and for red ink. Corrections shall always be in red, no erasures being made. Carter's Raven Black ink is suitable for obtaining blue prints.

A carefully selected and classified list of subjects for file numbers of computations has been prepared. This classification of subjects, with an explanation of its use, will be issued as a separate publication and assistants should study it so that computations may be made exactly in accordance with it. In this system numbers and letters are used to designate subjects and the nature of computations upon them. The list thus becomes an index showing the order of filing of computations, differing from the usual index in that it exists before the matter to be indexed is composed and constitutes a mould in which the matter is cast. The index therefore exists early in the work, instead of being delayed in formation until it is of little use.

In order that the index shall remain a true one, however, it is necessary that it shall be rigidly followed even when seemingly strained. To keep the work uniform a competent engineer should be designated in each office to supervise the selection of the file numbers and do the filing.

Before beginning any computation, the "File No.," given in the index of subjects, should be ascertained and inserted in the sheet, after which, under "Subject," should be written the classified subject and sub-division and, briefly and clearly, the nature of the computations. If the list of subjects seems inadequate or inapplicable in any case, the attention of the engineer in charge should be called to the matter so that a suggestion for improving the list may be sent to Headquarters and necessary additions or modifications made.

When as is usual a number of computations of various sorts are necessary to solve a comprehensive problem, the individual computations should be general in their application and elementary so far as possible, so that the individual computations may be useful in solving other problems. For such cases, the results only need be collected and used in solving the specific problem. In order, however, to show under what conditions the individual computations have been made, a reference to the main problem that occasioned them is to be placed, by subject, and by file and accession numbers, after the heading "Made in Connection with . . ."

In the space for "Acc. No." on each computation sheet is to be placed the department and division letters, followed by a hyphen, the letter denoting the computer, and the figures giving the serial number of the computation sheets used by the computer in question.

In each office, in addition to the engineer in charge of filing of computations, a man is to be designated to keep a stock of numbered sheets for each man belonging to the office. This rule has been found necessary to insure against duplication of numbers and uncertainty as to the next consecutive number. Temporary men or men doing little computing need not be given letters but may use sheets belonging to the men under whom they are working.

The signature of the person making the computation and of the one checking, as well as the date on which the computations are made, should be inserted in the places provided on each sheet. In writing the date, the month should be indicated by the first three letters of its name and not by a figure. In case it requires more than one sheet to complete a computation on a given subject, the sheets are to be numbered consecutively, 1, 2, 3, etc., in the space, Sheet No., and the whole number of sheets in the computation is to be inserted; but if one sheet only is used, these spaces should be filled with a dash.

Sufficient explanatory notes should be inserted

to make each computation perfectly clear and whenever data are taken from another sheet its file and accession numbers should be given in brackets. The letters indicating department and division should be omitted unless the reference is to a sheet of another department or division. Whenever referring to a drawing, use its accession number. A summary of the principal results of a computation should be made when it is evident that such a summary would be convenient for reference.

Under no condition shall a sheet be destroyed. If for any reason a sheet should become useless the prefix X, meaning superseded, is to be inserted before the file number and the sheet turned in with the other sheets at the proper time. "Superseded" should also be written or stamped in red across the face. Superseded sheets are to be filed in a separate book.

During the day while computations are being made or checked, assistants may, for convenience, remove the sheets from their individual computation books, but at night all sheets must be returned to the covers and fastened in. Avoid, so far as possible, having sheets with computations lying around loose. Suitable binders or covers are provided for the permanent filing of computation sheets, in which completed sheets will be arranged according to the system. Each binder should be plainly marked so as to show the file numbers included in it. These will be distinguished as reference computation books.

Whenever sheets have been completed and checked, they must be turned in promptly to the engineer in charge of filing computations, who will file them in reference computation books. Sheets which have been thus filed should seldom be removed and then only under such regulations for refiling correctly as the engineer in charge of filing may find suitable. Sheets fastened in covers must be turned with care to avoid damage.

If it should be found that an error has been made in any computation, the engineer in charge must be notified at once, so that the mistake may be rectified in all places affected. Be accurate, systematic and neat. Do not waste time on unnecessary refinement. Do not use more decimals than the accuracy of the data and the necessities of the result make advisable. Use slide rules, computing machines, logarithms and diagrams whenever their use will economize time and secure sufficient accuracy. Checking, especially of important computations, must be done independently. Going over the other man's figures is not checking. Errors in data, methods, deductions or judgment must be detected, as well as blunders in mathematics.

Make it a rule to use tabular form for computations whenever possible. A little preliminary thought will usually show a method of tabulation and the computation will be more quickly done, more likely correct and much more easy of reference, besides enabling additions to be made to widen the scope of the results. Mathematical work which can be done by slide rule or computing machine should be left off the sheets. The tabulation will indicate the process followed. Be brief. Use judiciously abbreviations which are sufficiently self-evident. Do not repeat unnecessarily. Do not waste time stating matters of common knowledge such as value of π and what it means, or deductions of formulas which can be readily found in text books.

STANDARD SYMBOLS FOR WIRING PLANS have been adopted by the National Electrical Contractors' Association, whose secretary, Mr. W. H. Morton, 94 Genesee St., Utica, N. Y., has ready for free distribution sheets giving full information concerning them. He has also been authorized to furnish at cost to engineers making plans for electric wiring sets of stamps for use in marking drawings, which will save considerable time.

Mechanical Plant of the First National Bank Building, Chicago.—II.

Heating System.—The First National Bank building is heated, in general, by direct radiation for which exhaust steam from the steam using machinery of the power plant is utilized, with the Webster system of steam circulation. The indirect system is used to a very limited extent, principally for fresh air supply in the more confined spaces in the basement and on the ground and main bank floors, the total capacity in blower equipment installed for indirect supply amounting to less than 35,000 cu. ft. of air per minute. In the entrance corridors the direct radiation is supplemented by ample supplies of hot air to counteract the cooling effect upon the upper corridors and halls of the cold air admitted in extreme winter weather.

In the distribution of the radiation the usual plan of locating radiators underneath the sills of outside windows has been followed on all floors, inside rooms without exterior exposure not being equipped with heating surface. The offices and suites on the upper floors all have window exposure, either to the outside or to the 60x90-ft. open interior court, and the radiators have been distributed on the general arrangement of one for every two windows. This distribution is exceeded somewhat under certain special conditions in some of the rooms, but, for a general average, there is installed one square foot of heating surface to every 65 to 70 cu. ft. of interior volume of the single rooms, whether facing the court or the outside. For the suites, which occupy the Monroe St. front and the alley front on the opposite side, the inside rooms of which have no heating surface, this average ranges from 100 to 125 cu. ft. of interior volume to each square foot of heating surface. The radiators used are 36-in. 2-column radiators, except in the corridors where 26-in. four-column radiators are used. The corridors are not supplied with radiation, excepting at points where windows open from them to the interior court and also at the windows at the rear of the bank of six elevators starting from the Monroe St. entrance. At this point are eight windows on each floor, which are fitted with six 33-sq.-ft. radiators, giving approximately 200 sq. ft. per floor; these radiators are all of the single-column type, 38 in. high.

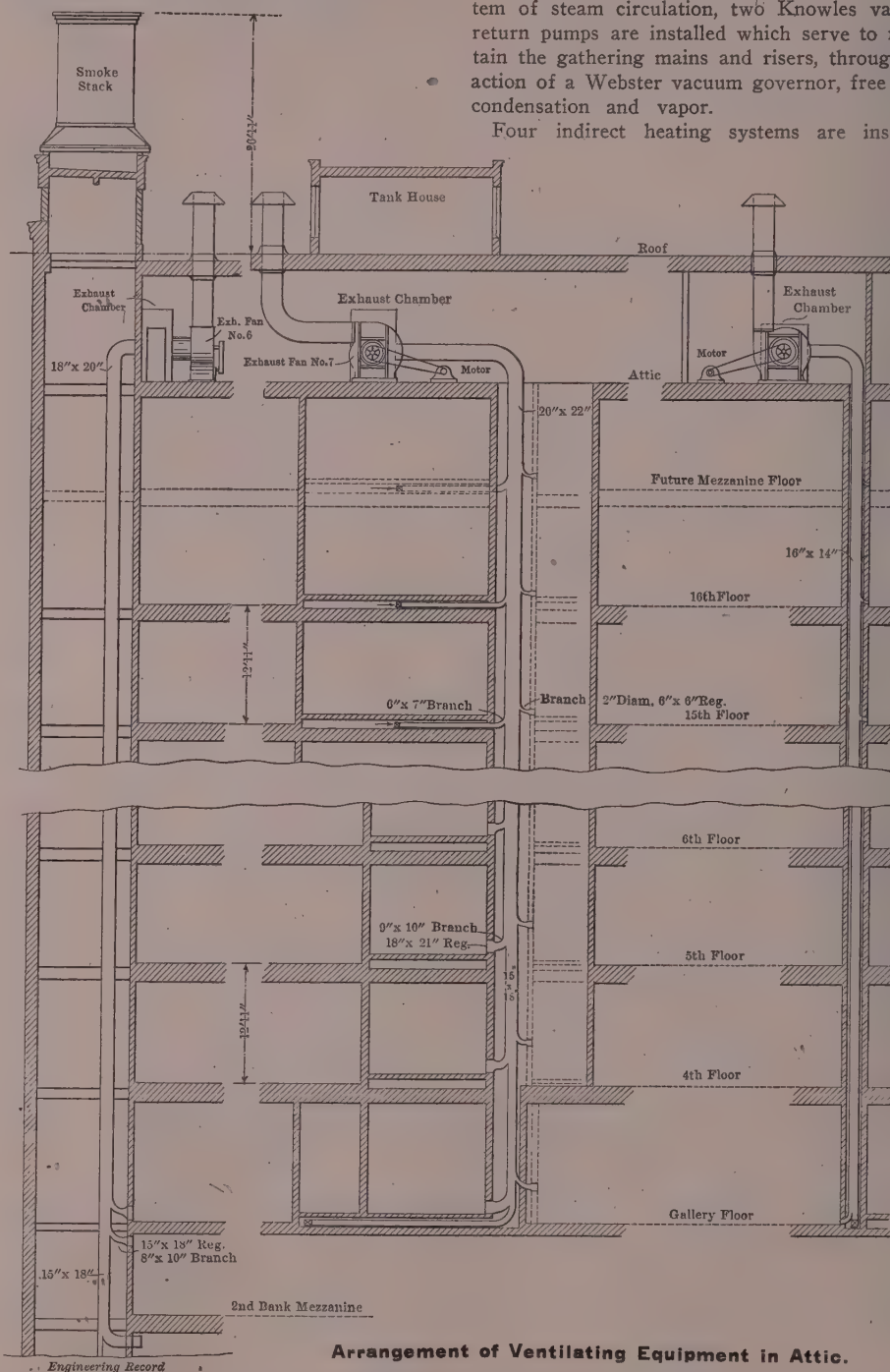
The heating of the ground floor, which is devoted mainly to stores opening out on the adjoining streets, of the main banking floor and also of the club room on the top floor, introduced special conditions. They were handled in much the same manner, however, in equipping with heating apparatus, except that radiation was installed in excess in some locations and also, that in the bank offices and club room are under automatic thermostat control. In the main bank office on the second floor all radiation is similarly located at the outer side walls. This room, which is 180x200 ft. in plan and 30 ft. in height at the outer sides, continuing in the center past an open mezzanine gallery to a skylight at the foot of the 60x90-ft. interior open court, has an interior volume of about 1,160,000 cu. ft. It is equipped with 55 radiators, 52 of 120 sq. ft. and three of 150 sq. ft., making an aggregate heating capacity of 6,690 sq. ft., or one square foot of heating surface per 175 cu. ft. of interior volume. The radiators used in this room are the 20-in. flue type with fresh air openings beneath the windows for ventilation purposes, foul air exhausting by natural draft through louvres in the skylight above.

The radiation in the building is supplied with steam by fifty-eight different risers which are distributed around the outside wall of the building and on the interior rows of columns, which carry the walls of the light and ventilation court above

the third floor. These risers are in all cases concealed in chases in the building finish, connections to radiators being made from them under the floor. The risers vary in size from 1½ to 3½-in. pipe and are supported at two points, the fourth and thirteenth floors, with expansion loops at the eleventh floor level in spaces in the floor provided for them. The average amount of radiating surface supplied from each riser is about 1,200 sq. ft., the total amount of radiating surface in the

two cases departure is made from this arrangement, one where two small risers serve a single 3½-in. supply riser and the other, where a 1½-in. return riser serves a 2-in. and a 2½-in. supply riser. These return risers connect in the basement to gathering mains which deliver the condensation to a vacuum system header in the pump room, from which the pumps remove it and deliver it through an air-separating chamber to the open feed-water heaters. For the Webster system of steam circulation, two Knowles vacuum return pumps are installed which serve to maintain the gathering mains and risers, through the action of a Webster vacuum governor, free from condensation and vapor.

Four indirect heating systems are installed



Arrangement of Ventilating Equipment in Attic.

building amounting to nearly 78,000 sq. ft. Of this latter amount, 2,015 sq. ft. is distributed in skylight coils and mains beneath the large 60x90-ft. skylight surmounting the bank rotunda, while the total on the ground floor and basement systems, amounts to 6,351 sq. ft. The heating supply risers all receive steam from the exhaust steam expansion tank in the pump room to which reference was made in the article descriptive of the power plant in the preceding issue, through separate supply connections, so that any portion of the system may be shut down without interference with any other.

The supply risers are all paralleled by return risers, which are in most cases of sizes one-half of that of the riser which they serve. In

one of which supplies heated fresh air in the different portions of the power plant, the second, to the Dearborn St. entrance, and the third and fourth to the trunk room, barber shop and the large bank storerooms in the basement. The blower equipments for these systems are located in a fan room at the rear of the central portion of the basement, having their intakes in a small areaway above that portion of the building and delivering to the portions ventilated through overhead galvanized-iron duct work. They are all fitted with air-washing equipments for the cleansing and purification of the air delivered to these portions and are fitted with both tempering and reheating coils. The arrangement of these blower equipments, air wash chambers, and the tem-

pering and reheating coils, are shown in the plan of the mechanical equipment in the basement of the building, which was published in the preceding article descriptive of the power plant.

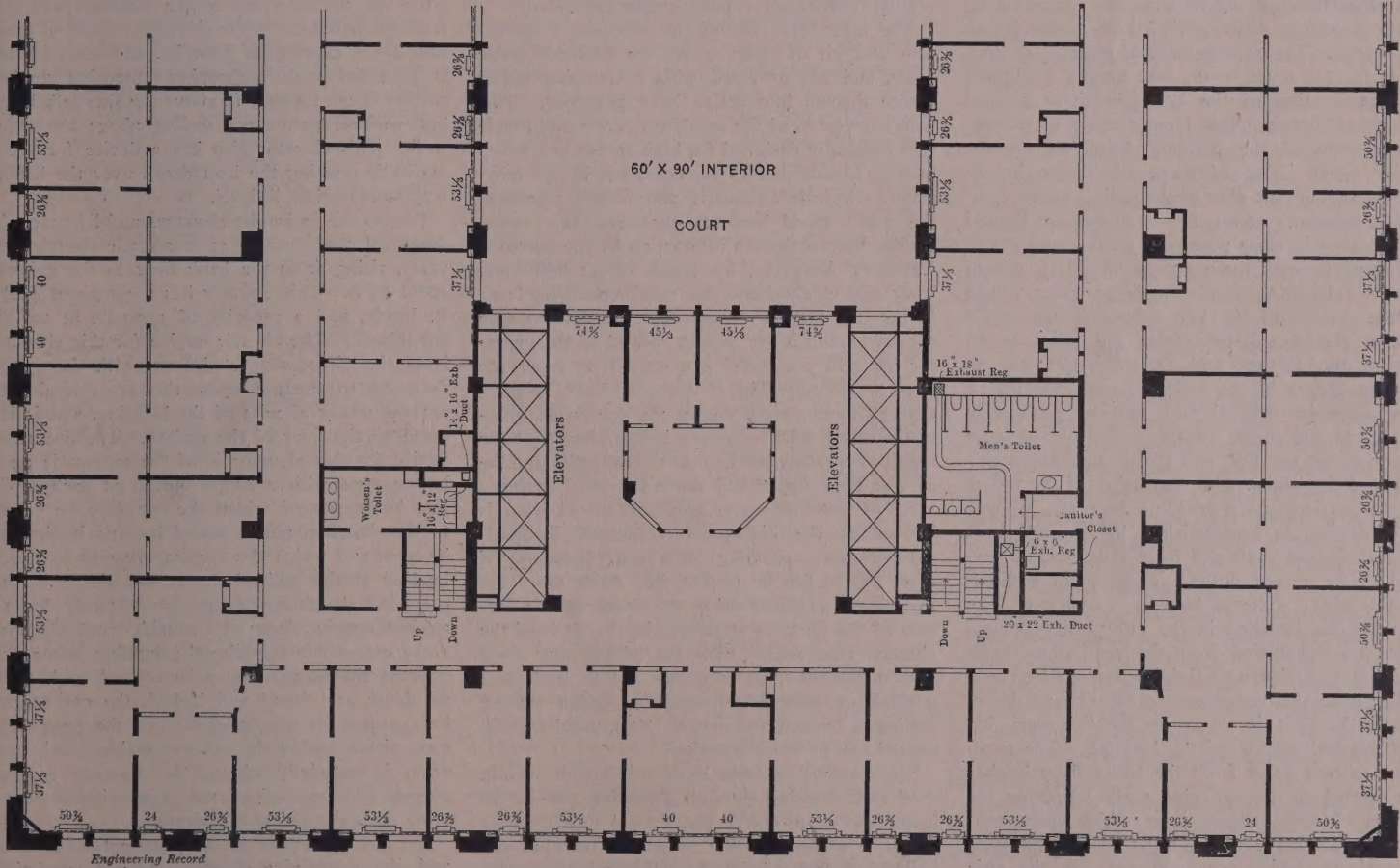
The principal details of the blowers, their speeds and capacities are indicated in the accompanying Table I. The duty of blower system No. 1, which is confined entirely to the power plant, involves the supply of 9,600 cu. ft. of air per minute to the boiler room, 8,400 cu. ft. per minute to the engine room and 3,600 cu. ft. to the fan room. Blower system No. 2 was installed solely to supply hot blast to the Dearborn St. entrance in severe winter weather in order to counteract the cooling effect of the opening and closure of doors near the entrance; the entire capacity of this blower is delivered into different portions of the entrance at a minimum temperature 70° Fahr. Blower system No. 3 is designed to deliver 2,900 cu. ft. per minute in the trunk storage vault, 500 cu. ft. to the barber shop, 760

ture of 70° Fahr. The action of these thermostats and automatic valves in temperature regulation, is supplemented by by-passes, one for either set of coils in each system. The by-pass damper at the tempering coil is adjusted to open at 60° Fahr., while that at the reheating coil opens at 70° Fahr. These heating coils are supplied with steam by a 6-in. main from the expansion tank which extends across the fan room with 2½-in. branches to each set of coils. The returns from the fan coils are handled by a 3-in. vacuum return line from the vacuum system header.

Owing to the large amounts of soot and dirt which it was foreseen would be inevitably drawn into the systems, owing to the location of the intake at the rear of the building on the fourth floor level, it was thought desirable to cleanse the air before entering the building by means of the air washing system. The air is drawn by the fan, in each case, through a tempering coil and thence through air washing apparatus, and

spray. The nozzles have, however, a lever attachment so that the spray attachment may be opened for a direct steam if necessary, in order to clear out any obstruction that may be carried into them with the water. The levers for all nozzles on each horizontal row are connected to a rod with a handle outside the casing, so that they may be operated from outside when necessary, a glass in the door in the casing facilitating examination of the interior.

The eliminator between the spray chamber and the fan arrests any water carried along mechanically with the air entering the system. Each eliminator has a number of rows of inclined baffle plates, which consist of vertical strips of sheet copper 6 in. wide with a hook edge on the side toward the fan, to engage particles of water coming in contact with the strips, due to the zigzag course of the passing air. In each system the eliminator is of a height and width equal to that of the spray chamber but is inclined slightly back-



Half Plan of an Office Floor Showing Distribution of Radiation.

cu. ft. in the large storeroom, and 130 cu. ft. in each of the eleven small storerooms, all in the bank storage section of the basement. Blower system No. 4 supplements system No. 3 in supplying the trunk storage vault, having duct connections for supplying 1,200 cu. ft. to this vault, and in addition supplies 1,200 cu. ft. per minute to the main safety deposit vault of the bank on the ground floor. The heating coils of the various system are designed for tempering and reheating air delivered at maximum capacity of each system to a temperature of 120° Fahr., each tempering and reheating coil consisting of three coils connected in a battery, with each section provided with an automatic valve.

The automatic valves of the tempering coils are operated by thermostats in the duct connections to the air wash chamber and so adjusted that steam is cut off when the outside temperature reaches 60° Fahr. The automatic valves on the reheating coils are adjusted for higher temperature, being intended to deliver at a tempera-

as each system has in addition to the tempering or preheating coil, a reheating coil in the fan delivery, the latter with automatic temperature regulation, automatic adjustment of the humidity of the delivered air is secured. This adjustment is accomplished by setting the preheating coil to heat the entering air to the temperature at which it will take up the required amount of moisture in passing through the air wash, after which it may be reheated to any desired delivery temperature.

The air-washing equipment consists of a spray chamber in which the air is drawn through a sheet of water spray before entering the fan, an eliminator between the spray and the fan preventing water being carried mechanically into the fan or delivery system. The spray nozzles are close together in staggered rows, and as the nozzles are of a side spray type, so that all deliver a sheet of spray at right angles to the line of flow of the air, the result is that the air cannot pass through the chamber without coming in contact with the

wards toward the spray chamber, which both facilitates the separation of water from the air on the baffle plates and also the drainage of water

TABLE I.—SPEEDS, CAPACITIES AND DETAILS OF BLOWER EQUIPMENT, FIRST NATIONAL BANK BUILDING.

No. of Blower.	Speed, r.p.m.	Delivery Pressure, ounces.	Capacity, cu. ft. per min.	H.P. of Motor.	Tempering coil, sq. ft.	Reheating coil, sq. ft.
1	187	0.464	21,600	17	1,080	1,080
2	274	0.32	4,500	225	225	225
3	337	0.504	5,500	280	280	280
4	285	0.263	2,400	120	120	120
5	345	0.525	5,875			
6	250	0.153	2,500			
7	221	0.268	6,275			
8	330	0.273	3,270			
Disc Fan	200	...	20,000	5		

from the latter back to the catch basin beneath the spray chamber.

The water for the nozzles is used over and over continuously for a number of days. The water circulated by centrifugal pump for each air wash,

which is belt driven by an electric motor. The pump in each case takes its suction from the catch-basin through a series of coarse and fine strainers, returning the water to the system through a line above the spray chamber which connects downward to the headers at either end of the nozzle supply pipe. The McCreery air washing apparatus is used in the systems, and was installed by Joseph McCreery, Toledo, Ohio.

Ventilating Systems.—There are, in addition to the indirect heating equipments, four exhaust equipments installed for ventilation purposes, one in the basement and the other three in the attic of the building. The former is installed for the ventilation of the barber shop, the trunk storage vault and other confined spaces in the basement together with toilet rooms in the basement and on the ground floor. One of the systems in the attic provides for the ventilation of toilet and locker rooms on the bank floor and mezzanine galleries, while the other systems operated from the attic ventilate the various toilet rooms on the office floors to which they are connected by vertical exhaust ducts carried down to the fourth floor level. The arrangement of exhaust connections for the toilet rooms was greatly facilitated by the location of the latter in three general groups at corresponding inner corners of the upper portion of the building adjoining the interior court. Two of these are shown in the accompanying part plan of the typical upper floor.

The exhaust systems, Nos. 7 and 8, are located in the attic in close proximity to the vent shafts rising up through these groups of toilets, system No. 7 exhausting from the large toilet rooms in the section of the upper floor shown, while system No. 8 exhausts from the toilet rooms nearest the Monroe and Dearborn Sts. corner. System No. 6 in the attic exhausts through a long 18x20-in. vertical duct, serving exclusively the toilets and locker rooms located on the bank floor and on the first and second mezzanine galleries of the bank. The ventilation of the toilets in the portion of the building over the Monroe St. entrance, is accomplished by natural draft through a vent shaft 4x6 ft. in cross section carried up to a roof outlet. There is in addition to the above exhaust blowers a 20,000-ft. disc exhaust fan installed in the attic which is provided for exhausting from the ventilation shafts which are carried up adjoining the smoke stack.

The general arrangement of the exhaust blowers in the attic is shown in the accompanying part vertical section of the building. The gathering system ducts from the lower floor intakes are carried up through pipe shafts adjoining the groups of toilet rooms from which short connections are made to the toilet rooms and janitor's closets which are ventilated. In the attic these ducts connect into exhaust chambers adjoining the fans from which the fans exhaust, delivering above the roof through outlets strongly built of No. 20 copper. These blowers are of the dimensions indicated in the accompanying table and are all belt driven by Crocker-Wheeler motors. These blowers were, together with those of the indirect heating systems, supplied by the American Blower Co., Detroit, Mich.

The heating and ventilating equipment of the building was designed by D. H. Burnham & Co., Chicago, Ill., who also acted as architects for the building. The steam generating and heating equipment was installed by Geo. E. Dixon & Co., Chicago, Ill.

Elevators.—The elevator equipment of the building embraces 22 elevators in all, which have varying travels and duties for the passenger service to the office floors, there is a main plant consisting of two banks, each of five passenger elevators, at the Dearborn St. entrance, and one bank, of six passenger elevators, at the Monroe St. entrance; and in connection with this bank, there is also a freight and passenger elevator.

Nine of the ten elevators, at the Dearborn St. entrance, have a travel from the first to the seventeenth floor, about 230 ft., and one elevator a travel from the basement to the attic, about 255 ft. Three of the elevators at the Monroe St. entrance travel from the first to the seventeenth floor, and three from the first to the attic, about 240 ft. All of the passenger elevators have cars about 6 ft. 2 in. x 5½ ft. inside, and a lifting capacity of 2,700 lb. at a speed of 300 ft. per minute and 1,200 lb. at 500 ft. per minute.

The combination freight and passenger elevator travels from the basement to the attic, and in ordinary service has a capacity of 3,100 lb. at a speed of 300 ft. per minute, but with the safe lifting pump, a capacity of 5,000 lb. at about 75 ft. per minute. The car of this elevator is about 7x8 ft. inside, and is arranged with corner posts to allow for openings on two sides at right angles. Owing to the large size and weight of this car, it is provided with an independent counterweight directly attached to the car in addition to the regular cross-head counterweight equipment.

The other cars are of the side-post construction and all of them travel on steel tee guide posts, and are provided with a clamping safety device thrown into action by a governor. This safety device is of the combined screw and toggle type especially designed for high speeds and heavy loads. In addition to its operation by the governor, which is automatic and occurs whenever the down speed becomes excessive, this safety device may be thrown into action by the operator whenever necessary, by means of an additional lever placed alongside the usual operating lever in the car, thereby rendering it possible to stop the car should it get beyond control of the operator but still not travel fast enough to cause the governor to act. The elevators all have, in addition to these safety appliances, the usual automatic valves which operate independently of the regular operating mechanism to gradually stop the cars at their upper and lower limits of travel.

All of these seventeen elevators are of what is known as the high-pressure geared inverted-plunger type, operating on a water pressure of from 750 to 800 lb. per sq. in. Aside from the high water pressure used, the characteristic feature of this elevator apparatus is, that it is of the plunger type rather than the piston type used with pressures usually under 150 lb. and is a pushing or compression machine rather than a pulling or tension machine, as is the usual vertical geared low-pressure machine.

The hoisting machine itself consists of a solid steel ram working through a stuffing box in the lower end of an extra heavy steel tube cylinder which is secured to the structural work of the building at such a height as will permit the proper stroke of the ram. Attached to the lower end of the ram is a heavy cast-iron housing in which are carried the three moving multiplying sheaves necessary for the 6:1 gear employed with these elevators. The stationary multiplying sheaves, or auxiliary sheaves, are mounted upon frame-work of the building at the seventh and eight floor levels. The traveling sheaves are guided between heavy steel tees, secured at one end to the lower cylinder flange and anchored below to solid foundation. Below the traveling sheaves and guided between the steel guides are heavy cast-iron weights counterbalancing most of the weight of the car and its fixtures.

With this construction it is possible to use a comparatively long ram, and therefore a lower ratio of gearing than would be required with other types of machinery; this lower ratio of gearing and the fact that only one set of packing (the ram packing) is used makes this type of apparatus very efficient as a machine compared to other geared types of elevator apparatus. The ram packing being outside also affords opportunity to observe the smallest amount of leakage,

thus making it possible to keep the packing tight and prevent the cars from settling, as is frequently the case with elevators having the piston type of machine. This type of apparatus has also the additional advantage of requiring less space for installation than the low pressure type.

In addition to the seventeen elevators already mentioned, there are two short rise bank elevators, the front one having a travel of about 60 ft., from basement to third floor, and a car about 7x5 ft., with a lifting capacity of 2,500 lb. at 300 ft. per minute. The rear elevator travels only from the main bank floor to the gallery, about 32 ft., having a car and lifting capacity to correspond to the front elevator. These elevators are of the direct lift plunger type, operating on the same water pressure as the main elevators. Owing to the length of travel of the rear elevator, an independent counterbalance is used for this elevator only.

There are also two direct lift plunger elevators, of the regular sidewalk type, one traveling from the sub-basement to the sidewalk and one from the basement to the sidewalk. Each of these lifts has a capacity of 3,000 lb., and one of them is provided with telescoping extension guides, so that it can travel 3 ft. above the sidewalk level, but without permanent guides above the sidewalk. This elevator also has a device for automatically opening the iron doors over the hatchway at the sidewalk level.

Besides the hydraulic elevators and lifts already described, there is also an automatic electric elevator, rising from the bank floor to the gallery, about 30 ft. This elevator has a car about 4x2½ ft. inside, and a capacity of 1,000 lb. at 100 ft. per minute. The electric engine for this elevator is of the direct connected type, with the motor designed to operate upon the 110-volt direct-current power circuits of the building, and is located on the floor of the gallery. The operating device for this elevator is of the automatic push button type with a single button at each landing, by means of which the car may be called to that landing, and a set of buttons in the car by means of which the car may be sent to either landing at the will of the person riding in the car. All hatchway doors are securely locked against opening from the outside until the elevator car stands opposite the landing, when the door at that landing may be opened, and, until all doors are closed and locked, the car cannot be operated by means of any of the push buttons, either within the car or outside. This elevator is especially adapted for the use of employees or customers of the bank, without maintaining a regular elevator operator.

For the operation of the hydraulic elevators and lifts, a pumping plant is provided, consisting of two pumps of the three-cylinder crank and fly-wheel high-duty type, built by the Laidlaw-Dunn-Gordon Co., of Cincinnati. Each of these pumps has a water end of the outside-packed-plunger type, single-acting, and a steam end of the Corliss engine type, designed to operate on a steam pressure of 150 lb. and to develop an indicated horse power with 26 lb. of dry steam per hour.

As a reserve, a compound duplex direct acting pump of the same make and of equal capacity of one of the high-duty pumps, and one smaller pump, of the same type, for night and holiday service, are installed. In order to provide the higher water pressure needed to enable the freight elevator to life the 5,000-lb. loads, a small simple duplex pump is provided, which is arranged to pump directly into the cylinder of the freight elevator. This pump is used only occasionally for lifting safes and very heavy weights and is controlled by hand.

For controlling the action of the other pumps, and for maintaining an approximately constant water pressure on the system, two weighted ac-

accumulators, one located near the Monroe St. bank and one near the Dearborn St. bank of elevators are provided. These accumulators are of about equal capacity, and are arranged so that the stopping or starting of the pump or pumps in operation is controlled by the action of the accumulator nearest the pumps, the other accumulator floating on the line as the pressure tends to rise or fall.

One peculiarity of this system of hydraulic elevators, as installed, lies in the method of control. The control of the cars is accomplished through the usual lever in the car, connected by wire ropes to a pilot valve at the machine, which controls the flow of water to and from a motor cylinder; this motor in turn moves the plunger of the main valve by which the stopping and starting of the car itself is accomplished, and in order to satisfactorily operate such a system, it is necessary to use a lower water pressure in the pilot valve and motor cylinder than the regular operating pressure of 750 lb. In order to do this, advantage is taken of the fact that the open discharge tank of these elevators is placed on the attic floor of the building, and from this discharge tank water is supplied to the pilot valves at a pressure of about 100 lb. In order that this water may not be lost from the system, it is discharged from the pilot valves into a small catch basin in the basement, and returned to the main discharge tank in the attic by means of pilot valve pumps, of which there is one compound duplex direct-acting for regular service, and one simple duplex direct-acting for reserve.

The main discharge tank is placed on the roof or in the attic, the most available location at a level above the upper end of the cylinders of the elevator machines, as it is desirable to put it above this level in order that the cylinder may not be drained should the operating valve be left open on the down motion with the car at the lower landing. Whatever power might be lost by forcing the discharge water to this point, is regained by supplying the water to the pumps from this tank at a pressure due to the height of the tanks above the pumps. The proportions of the pumps are such as to make them efficient in operating against the difference in pressure on the suction end and the pressure against which they operate.

This type of elevator has already become popular in Chicago and the West, where it is more generally known, since it appeals directly to architects and owners on account of the small amount of space required and to engineers on account of its high efficiency in operation, due not only to the actual economy of power consumed as a machine, but to its great promptness of acceleration and ease of handling. On the whole, it makes possible an elevator system which shall occupy the least space and carry the most people with the smallest number of elevators and minimum cost per car mile. The entire elevator equipment was built and installed by the Otis Elevator Co.

DRAINAGE OF THE SEPARATE STAGES OF A STEAM TURBINE of the Parsons type has been accomplished by an automatic method recently devised abroad. The drain holes in the bottom of the casing between every adjacent two rows of fixed blading, are connected to the upper ends of a series of U-shaped pipes. The first drain hole at the high pressure end is connected to the upper end of one leg of a U-pipe, the other leg of which is connected to the second drain hole. One leg of the second U-pipe is also connected to the second drain hole, and the other end of this pipe is connected to the third drain hole, and so on until the last leg of the final U-pipe is connected to the condenser.

Collecting Sewage Samples for Analysis.

In the control of many sewage disposal systems it is customary to send samples to a central laboratory at stated times in order to ascertain the degree of purification attained. These samples are not likely to be representative for several reasons, among them being the change in sewage which is kept for more than a short time. If some effective and simple method of preserving samples were employed, the analytical work would be much facilitated and the value of the results increased. The subject has been studied by Messrs. Stephen DeM. Gage and George O. Adams, who summarize their conclusions as follows in the "Journal of Infectious Diseases":

It is well known that considerable changes may take place in the composition of sewage and the effluents from sewage filters during short periods, and that the elapsing of a few hours between the time of collection and analysis may seriously affect the results of the analyses. Furthermore, samples collected at occasional intervals from sewers or from the effluents of sewage disposal works do not represent the actual average composition of waters from these sources. To be of the greatest value, samples should be collected at frequent intervals, preserved in some manner to prevent chemical changes, and then mixed in aliquot portions to form an average sample for analysis. Experiments at the Lawrence Station have shown that chloroform is a good preservative to use under these circumstances. From 10 to 20 c. c. of chloroform may be added to a gallon bottle, and small samples of from 100 to 200 c. c., collected daily, may be placed in the bottle, which is tightly stoppered; the average sample so obtained may be analyzed after any stated period without fear of material change in the individual samples of which it is composed. The principal errors which may result from such treatment are a small change in the nitrites, and the difficulty arising from the settling out of suspended matter. The nitrite difficulty may be obviated by taking occasional samples and doing nitrite determinations only. Any objection as to precipitation while the average sample is being collected affecting the determination of soluble and suspended organic matter may be overcome by filtering and preserving a separate portion of the daily sample. If such methods be carried out in practice, it is believed that they will result in a more accurate knowledge of the composition of applied sewages and the effluents from sewage disposal works, and will yield more accurate information as to the purification accomplished by the different methods of sewage disposal.

Letters to the Editor.

HOW TO SELL GOODS IN BRAZIL.

SIR: There is undoubtedly a large market in Brazil for manufactured articles from the United States—machinery, hardware, novelties, agricultural implements, automobiles and other vehicles, typewriters, shoes, textiles, drugs and proprietary medicines, food preparations and beverages, perfumes, paints, oils and varnishes, furniture, roofing, clocks and watches, steam and electrical specialties and the like. Manufacturers of such articles are probably more interested in some practical suggestions as to how they can market their products in Brazil than in an essay treating of the general commercial situation.

To begin with, the fact should be borne in mind that the conditions all favor a large trade between the United States and Brazil. The United States is Brazil's best market, taking more than half of her entire exports. We admit free of duty her coffee (to the extent in 1905 of \$64,136,008), her

India rubber (\$28,476,252), her cacao (\$1,238,859), her hides and skins (\$2,364,207 free, besides \$507,936 dutiable), her manganese ore and oxide of manganese (\$990,044), making with other articles a total of 1905 free of duty of \$97,966,274. It will thus readily be seen how seriously the prosperity of Brazil would be affected were we, for example, to impose even a small tax on her coffee.

The important special concessions recently made by Brazil in favor of certain lines of American goods and the answer which Brazil has made to other countries, which objected to the preferential arrangement with us, and which claimed equal privileges (under the favored nations' clause in their treaties) demonstrated that the statesmen of Brazil appreciate the situation. They frankly point out to these other countries that the commercial relations existing between the United States and Brazil are unique and that this is the reason why the special advantage is given to the United States.

It is considered not unlikely that rebates will be made from time to time on other lines of American manufactures; in fact American exporters may be able to secure additional concessions if they will only present the matter forcefully before the State Department. Secretary Root takes more than the ordinary patriotic interest in the extension of American foreign trade. He is now personally known to and highly esteemed by Brazilian officials. Never before have the Brazilians received a foreigner with such marked attention. A request later from the State Department is likely to receive careful consideration. If American manufacturers do not get further tariff advantages in Brazil, the fault will be entirely their own.

The merchants of Brazil complain that while their customers demand and they are anxious to handle American goods, they are handicapped by the fact that the manufacturers of the United States insist on spot cash payments, while they themselves can only sell their goods by giving their customers extended credit. True, they get liberal interest, usually 12 per cent., but as German and British manufacturers make no objection to giving credit, American manufacturers certainly lose many orders by not following the practice of other nations in this respect. Even where a Brazilian is able to pay cash, he resents as a personal slight, insistence upon prompt payments. The Brazilian prides himself upon keeping his financial obligations and comparatively little is lost in bad debts.

Manufacturers of the United States who are in a position to grant credits and who wish to do something approaching the maximum business open to them in South America may find on investigation that the risk involved is less than they have imagined. In nine cases out of ten when I ask a merchant what American manufacturers should do to increase their volume of trade in Brazil the matter of credits is what he mentions first. Dealers complain, too, that while the first letter they receive from an American manufacturer usually gives promise of opening up satisfactory business relations, the second one, in answer to their inquiry for prices and terms is so full of restrictions and an apparent lack of confidence in their commercial honesty that hope of inaugurating a business connection vanishes.

Germans are doing much of the business in Brazil that was formerly carried on by British manufacturers. This is due, primarily, to the fact that the German salesman is particularly well equipped in business training, languages and adaptability to secure the confidence of the Brazilians, and secondly, to the fact that German houses will modify their goods to meet the special Brazilian requirements. At the same time, German goods are not well thought of in Brazil,

and where the proper effort is made American goods will always sell in preference to German goods even at a considerably higher price. For example, nine-tenths of all the electrical machinery in Brazil is American.

The head of the leading department store in Rio de Janeiro told me that it was only after several years of effort that they succeeded in getting an American shoe manufacturer to make shoes in the way they wanted them. Now they are selling hundreds of thousands of pairs of his shoes. They formerly sold only English shoes. They are so well pleased with their success in shoes that they have asked me to put them in touch with American manufacturers in other lines. A partner of one of the most prominent of the retail houses on the principal shopping street—the Rua Ouvidor—showed me some food products from the United States made by one of the best of our manufacturers, which had spoiled on account of the damp climate. He said the goods sold splendidly, but as they are packed in pasteboard boxes instead of in tin, only a part of each shipment is fit to use. The reputation of the food as well as of the merchant suffers in consequence. The merchant wrote to the manufacturer offering to pay the additional expense of having the food put up in tin boxes but received the reply that the manufacturer did not care to make any change in the packing. Possibly this company is wondering why its sales are not increasing in Rio.

The German manufacturer through his salesman studies conditions in each country. For instance, I met here the representative of a German manufacturer of a high grade of patent leather. I learned from him that his concern sends experts not only to Brazil but to India, Australia, etc., and that it makes a special patent leather for each country, adapted to the particular climatic conditions of that country. Another German salesman told me that certain of his goods he never attempts to sell in the larger cities and certain others he disposes of altogether in the cities. The sale of some goods he confines to certain cities and he makes up lines of samples for particular houses. While he usually remains out here for more than a year, there are certain times when he is away from Brazil for a considerable period. To keep in touch with his customers, however, he prepares lines of samples for each concern with whom he does business. In case he cannot call upon a particular customer when that customer is making his purchases, he sends him the samples and writes him. This salesman pays a small commission to agents in each of the cities in which he does business. This is to secure their cooperation in closing orders—though he himself solicits the business personally—and their assistance afterward in connection with the delivery of goods, making collections, etc. He has made gradual but radical changes in the discounts to commission houses. The present discount is but one-fifth what was formerly paid. He says, however, that the reduction in discounts has had no appreciable effect on the sales made through commission houses. In other words, his own efforts combined with advertising, create a demand for the goods, part of which is filled through commission houses. He cannot trace any orders due to the initiative of commission houses and for that reason thinks that a nominal discount will bring him, practically as much business from commission houses as would a large discount.

It is found in practice that in South America the best results are obtained from a salesman who is paid a liberal salary with a small commission on sales. The salesman is depended upon to determine the line of credit in each case. In some instances a part of any losses from bad debts is deducted from his commissions. A

man who is trusted with an important territory so far from his home office may be relied upon to be exceedingly conservative in granting credits.
RIO DE JANEIRO, Aug. 1. W. J. JOHNSTON.

PROPORTIONING OF REINFORCED-CONCRETE COLUMNS.

SIR: In the discussion which has been going on in your columns lately relative to the design of concrete columns reinforced with vertical rods, there seems to be one important point which has not been touched upon. The writer would be glad of any additional light which may be had upon the subject through your columns.

In proportioning concrete columns reinforced with vertical rods, the formula: Safe Load = $S(A_c + 15 A_s)$ is largely used, especially by the engineering departments of companies manufacturing some form of reinforcing rods. S , being the allowable unit stress on the concrete does not exceed 450 lb. per square inch in good practice. A_c and A_s are the areas of the concrete and steel, and 15 is the value given to the ratio of the modulus of elasticity of the steel to that of the concrete.

The error in this formula, in the writer's opinion, is in the use of such a high value for the ratio of moduli of elasticity. The use of a high value for this ratio is not on the side of safety as in the case of beams, as it here assumes a

of a county and State system of main or market roads equitably apportioned among the counties and covering a distance of 7,500 miles. Of this, 692 miles have already been improved and plans for the improvement of 1,550 miles have been approved by the boards of supervisors, leaving 5,450 miles of additional roads, the improvement of which is suggested.

Second, by extending State aid to all towns which have substituted for the antiquated system of working out the road tax, the more modern and business-like method of paying same in cash. Five hundred and thirty-three towns, containing 45,005 miles, have adopted this money system, and many of the remaining 399 towns, containing 30,083 miles, are rapidly following their example.

The fact that two-thirds of the towns of the State have voluntarily adopted the money system of maintenance of roads, is shown on the map hereinafter referred to. The realization of this fact should induce the voters of the remaining towns or the members of the Legislature to provide for the adoption of the money system method of maintenance of roads in such towns, in order that the entire State may have a uniform system for maintaining its highways.

The responsibility of all of this work is, by law, placed upon the department of the State Engineer and Surveyor.

TABLE 1.—TEST OF CONCRETE COLUMN NO. 1579, MADE AT THE WATERTOWN ARSENAL DURING 1904.
(Applied loads) On 50-in. gauged length. Computed stress on bars. Per cent. of load.

Total, lb.	Per sq. in., lb.	Compression, Inch.	Set, Inch.	Resilience, Inch.	Per sq. in. Lb.	Total, lb.	Total stress on concrete by diff. Lb.	Increment on concrete, Lb.	On concrete.	On bars.	Stress per sq. inch on concrete, Lb.	Ratio pounds per sq. in. of concrete.
15850	100	0.	0.	0.	540	1787	29913	13466	94.4	5.6	193	2.8
31700	200	.0009	0.	.0009	1260	4171	43379	13269	91.2	8.8	280	4.6
47550	300	.0021	0.	.0021	1800	6752	56648	13069	89.4	10.6	365	5.6
63400	400	.0035	.0001	.0034	2400	9533	69717	13009	88.0	12.0	449	6.4
79250	500	.0049	.0001	.0048	2880	12512	82588	12871	86.8	13.2	532	7.1
95100	600	.0065	.0002	.0063	3780	15292	95658	13070	86.2	13.8	616	7.5
110950	700	.0081	.0004	.0079	4620	18470	108330	12672	85.4	14.6	698	8.0
126800	800	.0097	.0004	.0093	5580	21250	121400	13070	85.1	14.9	782	8.2
142650	900	.0112	.0005	.0107	6420	24229	134271	12871	84.7	15.3	865	8.5
158500	1000	.0128	.0006	.0122	7320	27407	146943	12672	84.3	15.7	947	8.7
174350	1100	.0145	.0007	.0138	8280	30783	159477	12474	83.8	16.2	1030	9.0
190200	1200	.0164	.0009	.0155	9300	33961	172089	12672	83.5	16.5	1109	9.3
206050	1300	.0181	.0010	.0171	10260	40316	197434	25345	83.0	17.0	1272	9.6
221750	1400	.0216	.0013	.0203	12180	47465	221985	24551	82.4	17.6	1430	10.0
237550	1500	.0255	.0016	.0239	14340	54814	246336	24351	81.8	18.2	1587	10.4
253400	1600	.0297	.0021	.0276	16560	58786	258214	11878	81.5	18.5	1664	10.7
269450	1700	.0320	.0024	.0296	17760	74674	305726	47512	80.4	19.6	1970	11.5
301150	1900	.0411	.0035	.0376	22560	86788	325312	19586	78.9	21.1	2096	12.5
317000	2000	.0484	.0047	.0437	26220							
380400	2400			Ultimate strength								
412100	2600											
438000	2760											

1:2:4. Concrete mixture, pebbles. Gross sectional area of column, 158.5 sq. in. net sectional area, 155.19 sq. in. mean area of steel 3.31 sq. in. Column reinforced with eight 3/4-in. Thaxter bars. Age of column, 3 months 12 days.

greater load on the steel than it actually carries, the balance being thrown onto the concrete.

In the accompanying table which is taken from the report of the full size tests made at Watertown Arsenal during the year ending June, 1904, the value of this ratio, within the limits of allowable working stress, is seen to vary from 2.8 for a stress of 193 lb. per square inch on the concrete to 6.4 for a stress of 449 lb. per square inch. This table is only one of a number given in the report above referred to, all of which, for good mixtures, show approximately the same values. The greatest variation from this one does not give a value of over 10, for stresses below 500 lb. per square inch; 8 being a high value for many cases. It therefore seems to the writer most unreasonable to assume that the steel will carry 12 or 15 times as much load per unit area as is carried by the concrete. A value of from 6 to 8 would seem to cover most of the first-class concretes usually specified.

YOUNG ENGINEER.

New York, Sept. 17, 1906.

HIGHWAY IMPROVEMENTS IN NEW YORK.

SIR:—As you are doubtless aware, the State of New York is now, for the first time in its history, pursuing a systematic plan for the construction, maintenance and repair of the 75,000 miles of highways within its boundaries.

First, by extending state aid in the construction

For the purpose of assisting the department in its duties, and to aid supervisors, highway commissioners and other town officials in familiarizing themselves with the numerous laws governing this work and the duties imposed upon them thereby, and in compliance with that portion of the State Aid Law which directs the State Engineer to compile statistics relative to public highways throughout the state, and disseminate the same, I have just issued Road Red Book, Bulletin No. 12.

Accompanying this Bulletin is the first road map of the State of New York ever prepared, on which is designated the system of highways proposed to be improved, and the towns which have adopted the money system. This map, showing the roads suggested for improvement, is prepared for the purpose of awakening interest and facilitating the work of the next Legislature in selecting those roads of the State in each county which should constitute the best State and county system contemplated by the law. When adopted by the Legislature all moneys thereafter expended under the fifty million dollar bond issue, should be confined to the roads thus selected. By this means when the fifty million dollars is expended, the State will have a system of connecting roads for each county and also for the entire State.

Very truly,
Albany, Sept. 19. HENRY A. VAN ALSTYNE.
State Engineer.